



REVISION OF CNS MODULE RESET 2025

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Anatomy and development of spinal cord

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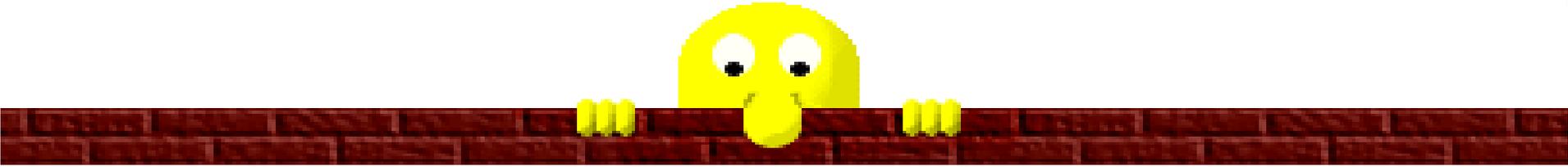


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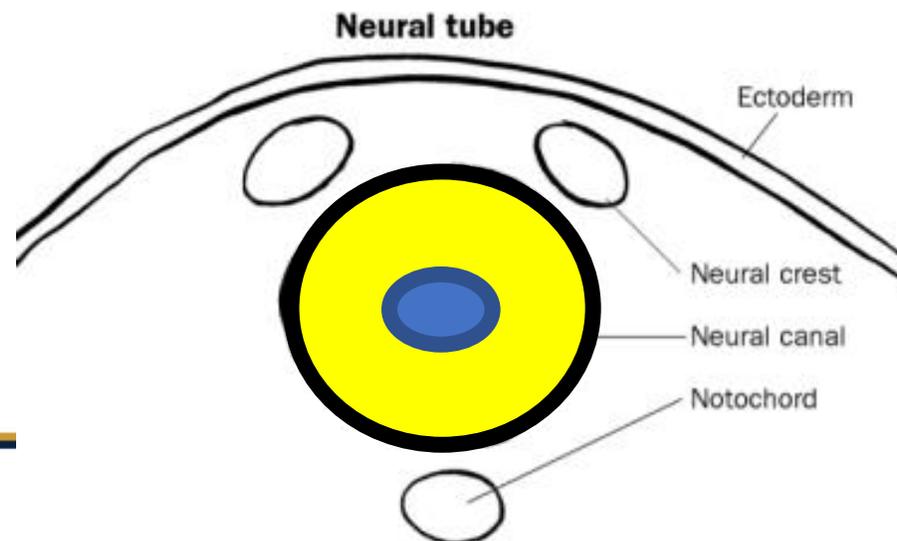
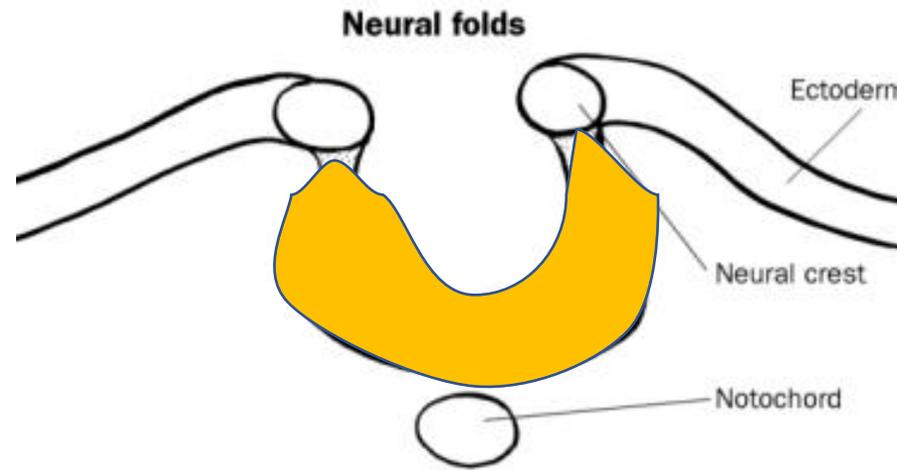
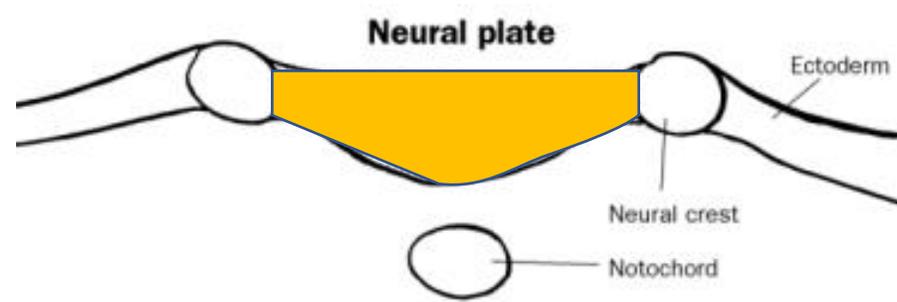




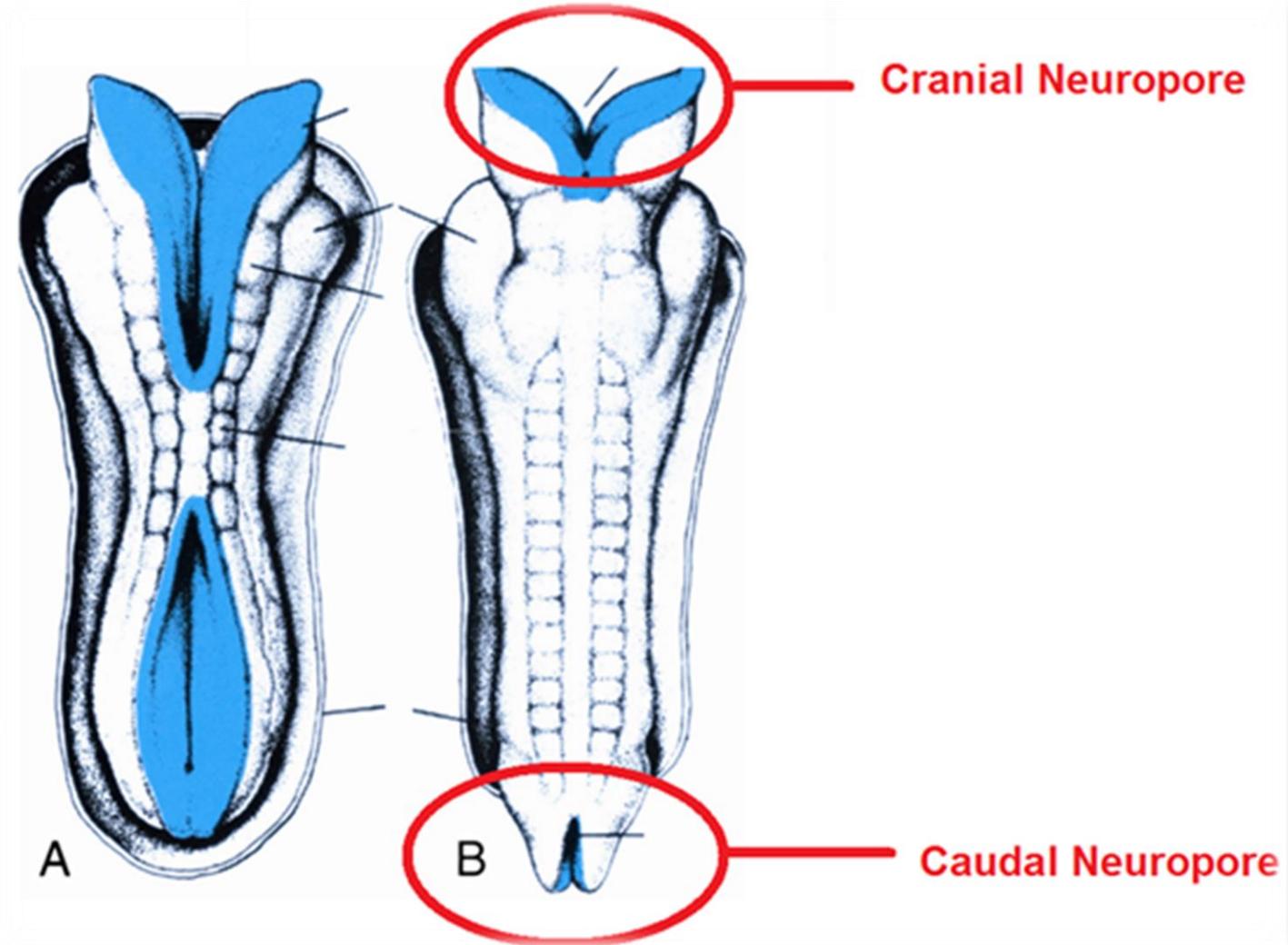
Development of Nervous System

Outline of development of nervous system

- 1. The neural plate:** appears early on the **3rd week** as a thickened ectoderm in the middle line. The inducer (**organizer**) is the **notochord and paraxial mesoderm**.
- 2. The neural folds:** The lateral edges of the plate become elevated.
- 3. The neural groove:** The depressed region between the folds.
- 4. The neural tube:** At the beginning of the **4th week**, the neural folds become more elevated, approach each other in the midline and finally fuse to form the neural tube. **It begins in the region of the fourth somite** and proceeds in both cranial and caudal directions.



- The **cranial opening** of the tube (**anterior neuropore**) closes on the **25th** day. MCQ
- The **caudal opening** of the tube (**posterior neuropore**) closes on the **27th** day. MCQ



Early Development of the spinal cord

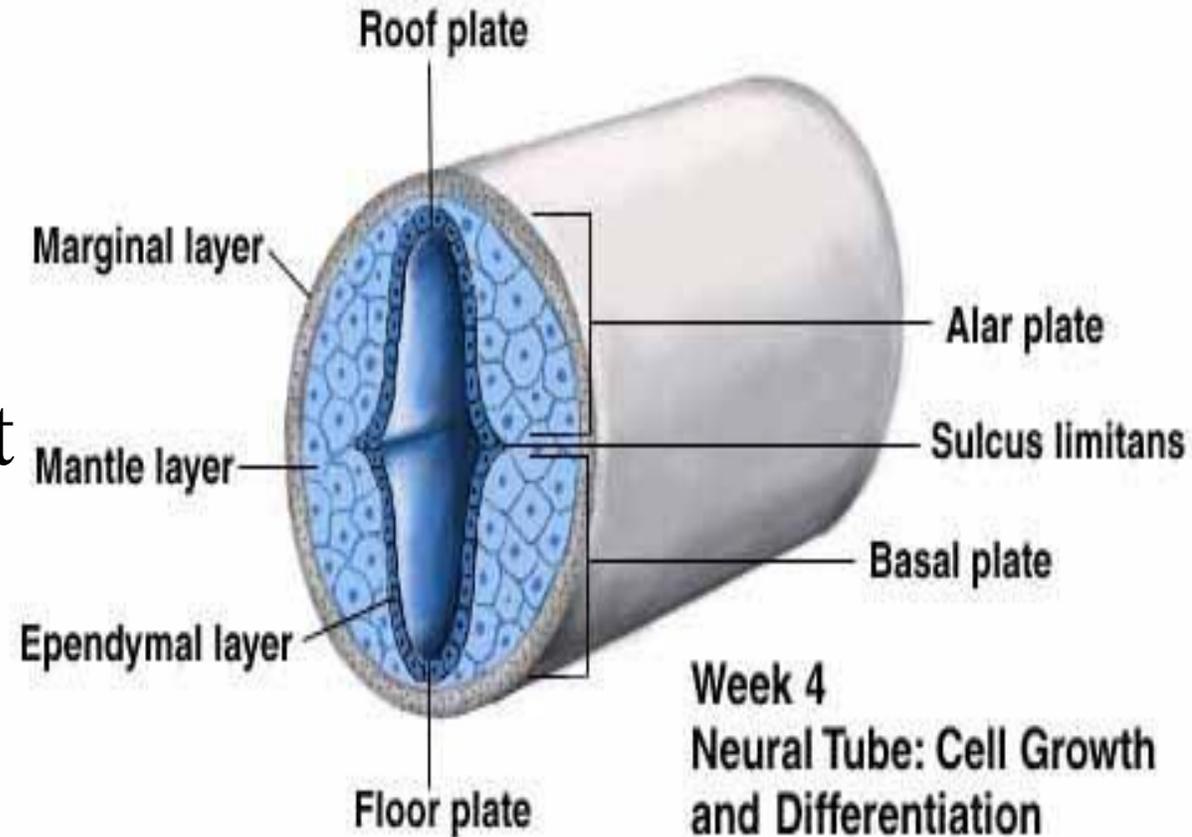
The caudal portion of the neural tube forms the spinal cord, and the cranial portion will broaden and forms the brain

MCQ

SAQ

The neural tube has 3 layers:

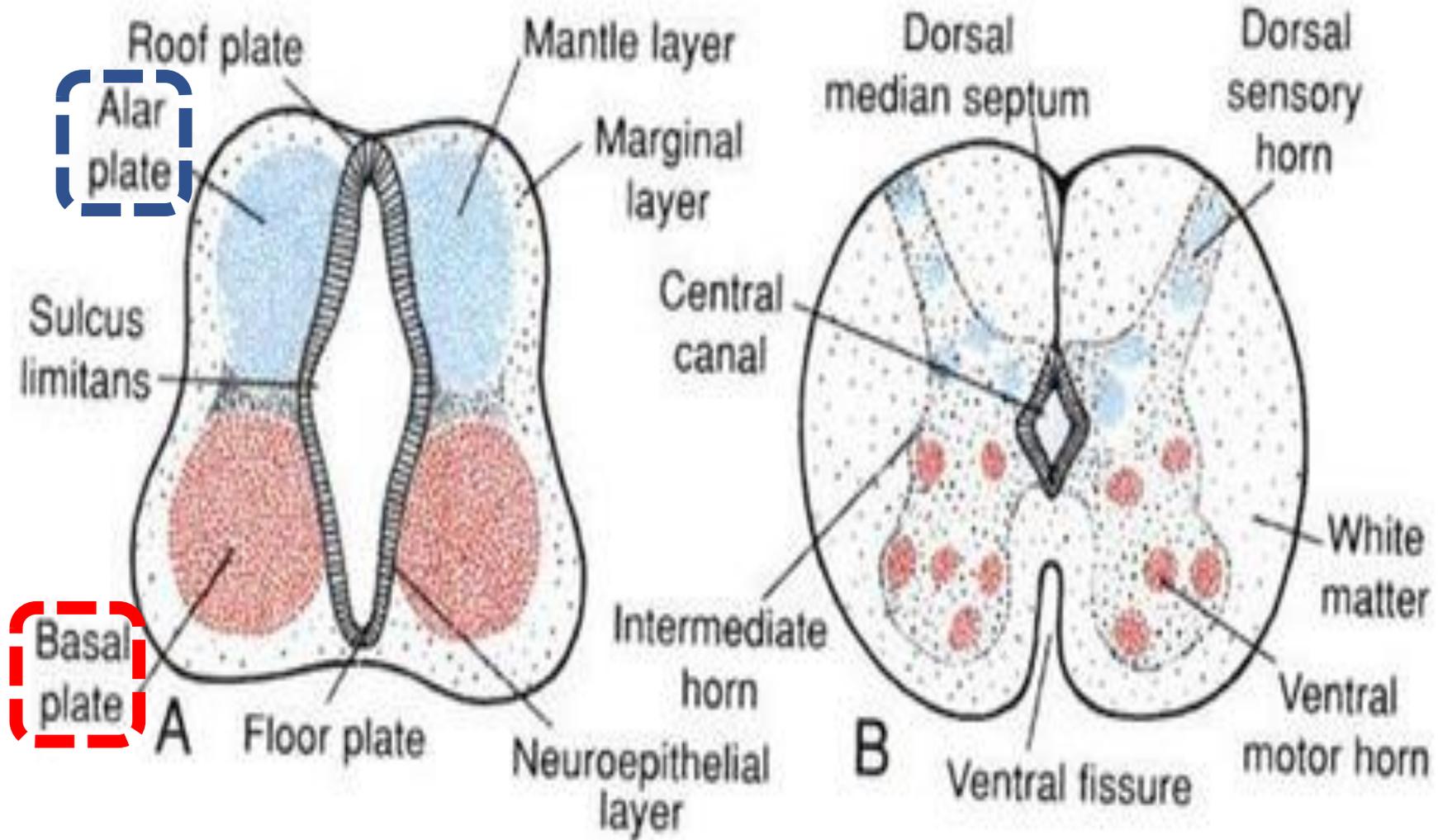
1. **Ependymal** layer: The original neuroepithelium (stem cells of nervous system). **MCQ**
2. **Mantle** cell Layer: neuroblast cells. (The Gray Matter).
- 3) **Marginal** layer: neuroblast fibers (The white matter).



Late Development of the spinal cord

With continuous proliferation of neuroblasts each side of the neural tube shows:

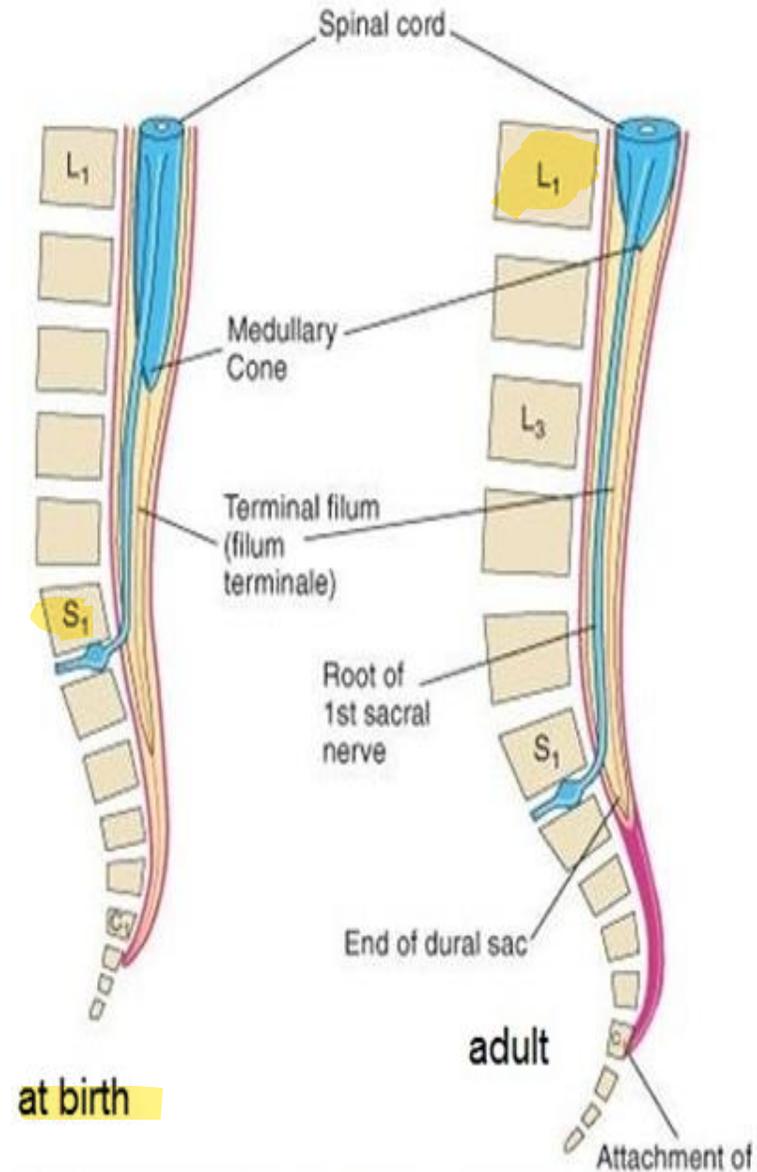
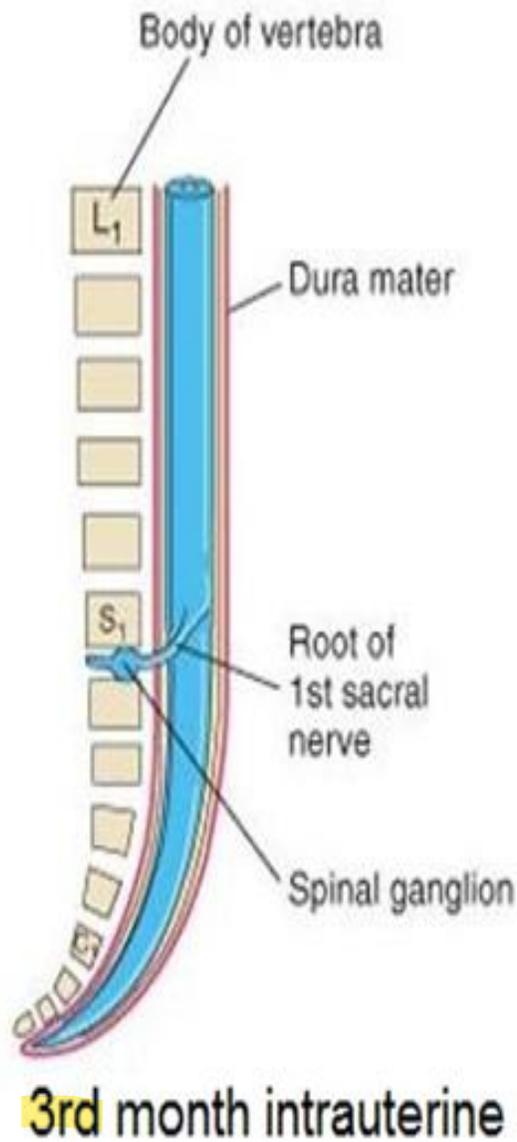
1. Ventral thickenings, **the basal plates**, contain the anterior **motor** horn cells. Later, they will bulge ventrally on each side of the midline, causing a deep longitudinal groove on the ventral aspect of the spinal cord for the anterior spinal artery.
2. The dorsal thickenings, **the alar plates**, form the posterior **sensory** horn cells. Later they will expand in a medial direction and fuse to form the posterior median septum.
3. **The area between the alar and basal plate**, Neurons proliferate and form **the intermediate horn** (This horn contains mainly motor neurons of the autonomic nervous system).
4. A longitudinal groove, the **sulcus limitans**, found bilaterally on the inner surface of the tube, marks the boundary between the anterior motor and posterior sensory areas.



SAQ

Age related changes In the position of the spinal cord

- 1) During the 3rd month intrauterine: extends through the **entire length** of the vertebral canal. **MCQ**
- 2) Later intrauterine: the spinal cord **ends at the level of the 1st sacral vertebra.**
- 3) At birth, this end is located at the **level of the third lumbar vertebra.** In the adult, the spinal cord terminates at the **level of the lower border of the first lumbar** vertebra. The nerve Fibers below the terminal end of the cord are known as the **cauda equina**

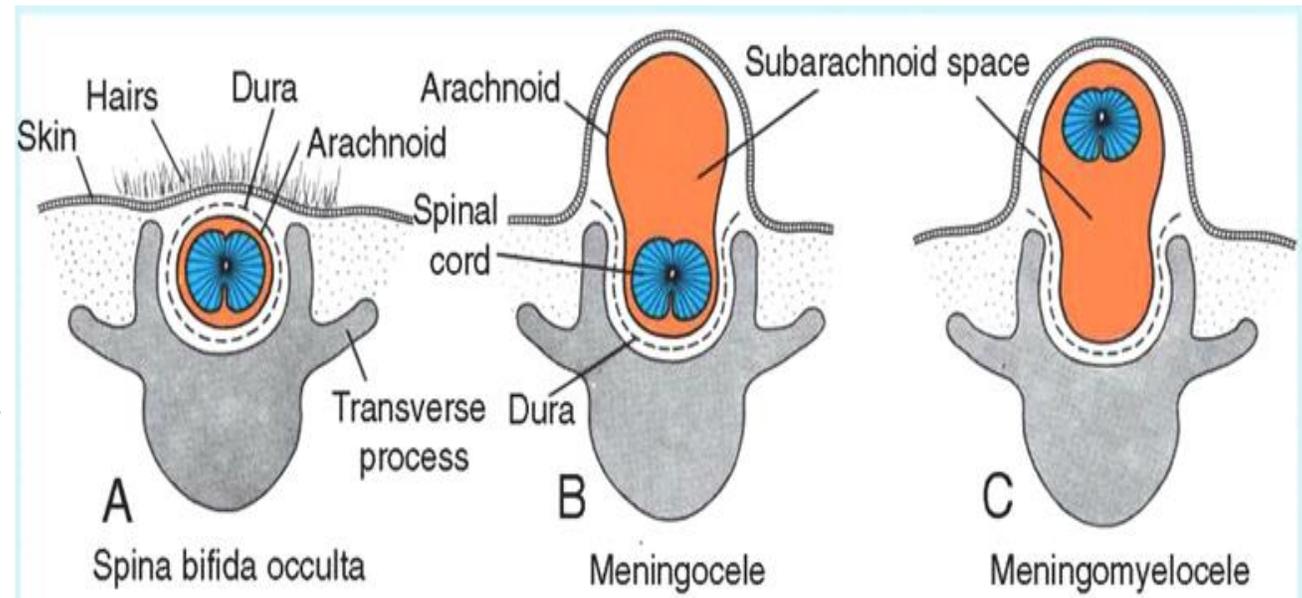


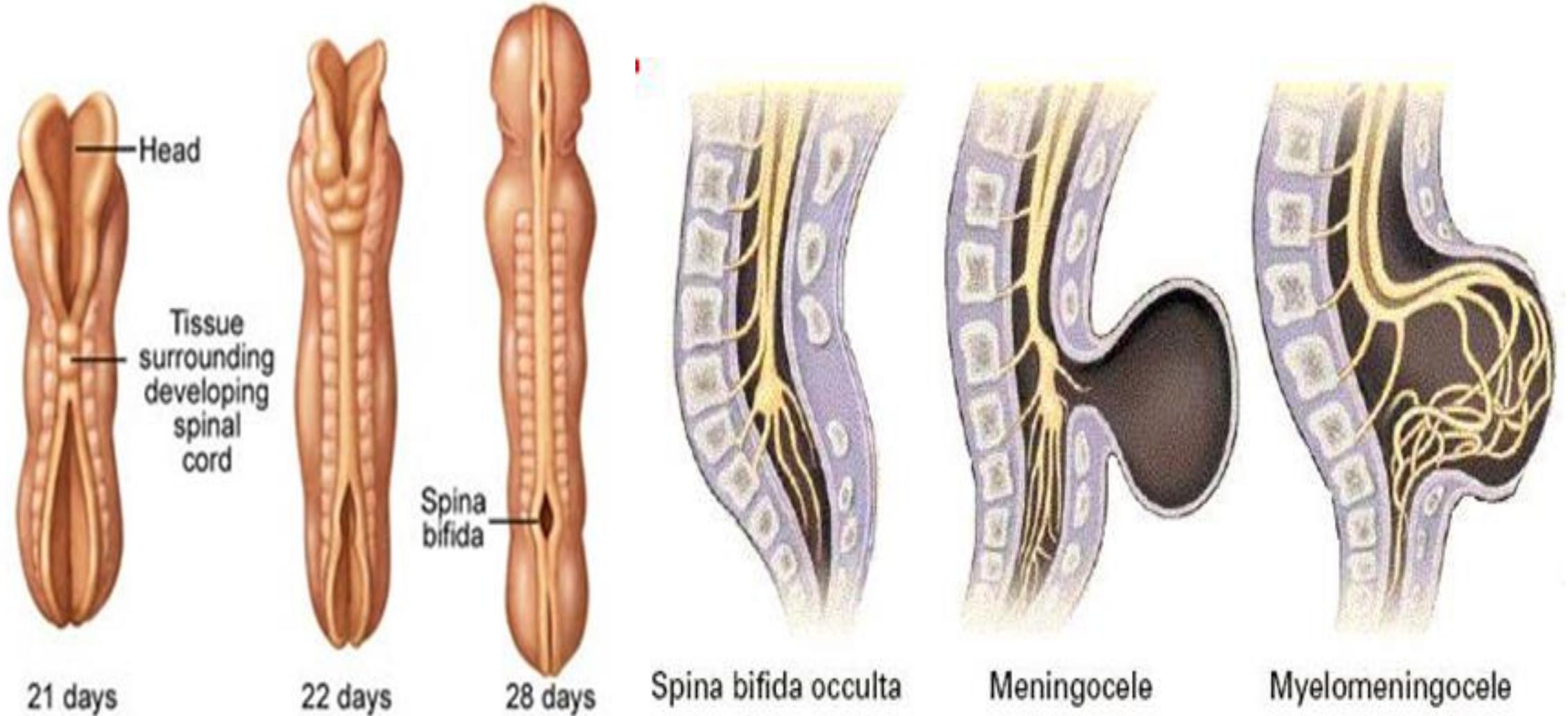
Congenital anomalies of the spinal cord

“NEURAL TUBE DEFECTS”

SAQ

- 1) Spina bifida.
- 2) Spinal dermal sinus.





1. Spina bifida

Cause: non-fusion of the embryonic halves of the vertebral arches.

A. Spina bifida occulta:

Cause: failure of the embryonic halves of one vertebral arch to grow and fuse in the median plane.

Features:

- Occurs in **L5 or SI**
- Occurs in **10%** of normal people.
- Produces **no clinical symptoms.**
- The only evidence of its presence may be a small dimple with a tuft of hair arising from it in the lower lumbar or sacral regions.



B. Spina bifida with meningocele

Cause: failure of the embryonic halves of the vertebral arches of more than one vertebra to grow and fuse in the median plane.

Features: There is cyst like sac which contains **meninges** and cerebrospinal fluid.

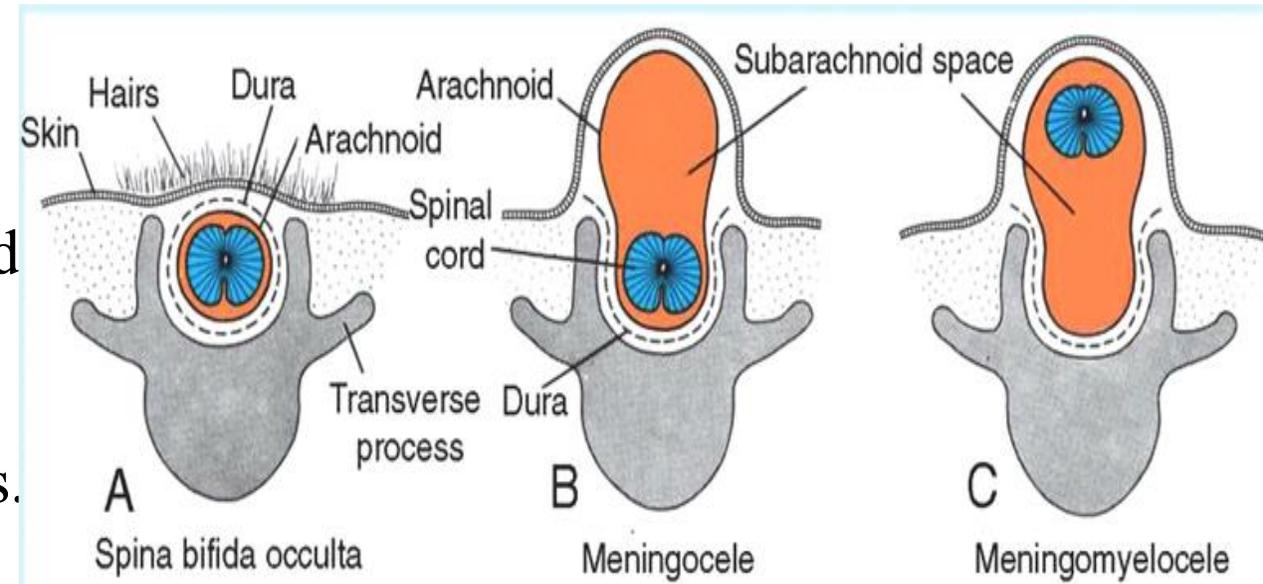
C. Spina bifida with meningomyelocele

MCQ

Cause: failure of the embryonic halves of many vertebral arches to grow and fuse in the median plane.

Features:

- There is cyst-like sac.
- The sac contains **meninges**, cerebrospinal fluid **spinal cord** and/or spinal nerves.
- Shows severe neurological deficit.
- They are common in lumbar and sacral regions.



D. Spina bifid with myelocoele (Rachischisis)

Cause: Failure of the neural arches of many vertebrae to grow and fuse.

Features:

- **The spinal cord is widely exposed** to the surface.
- The myelocoele shows severe neurological clinical signs.
- It is strongly suspected in-utero when there is a high level of **alpha-fetoprotein** in the amniotic fluid.

MCQ



2. Spinal dermal sinus

Cause: failure of closure of the caudal neuropore at the end of the fourth week.

Features: There is a posterior skin dimple in the median plane of the sacral region.

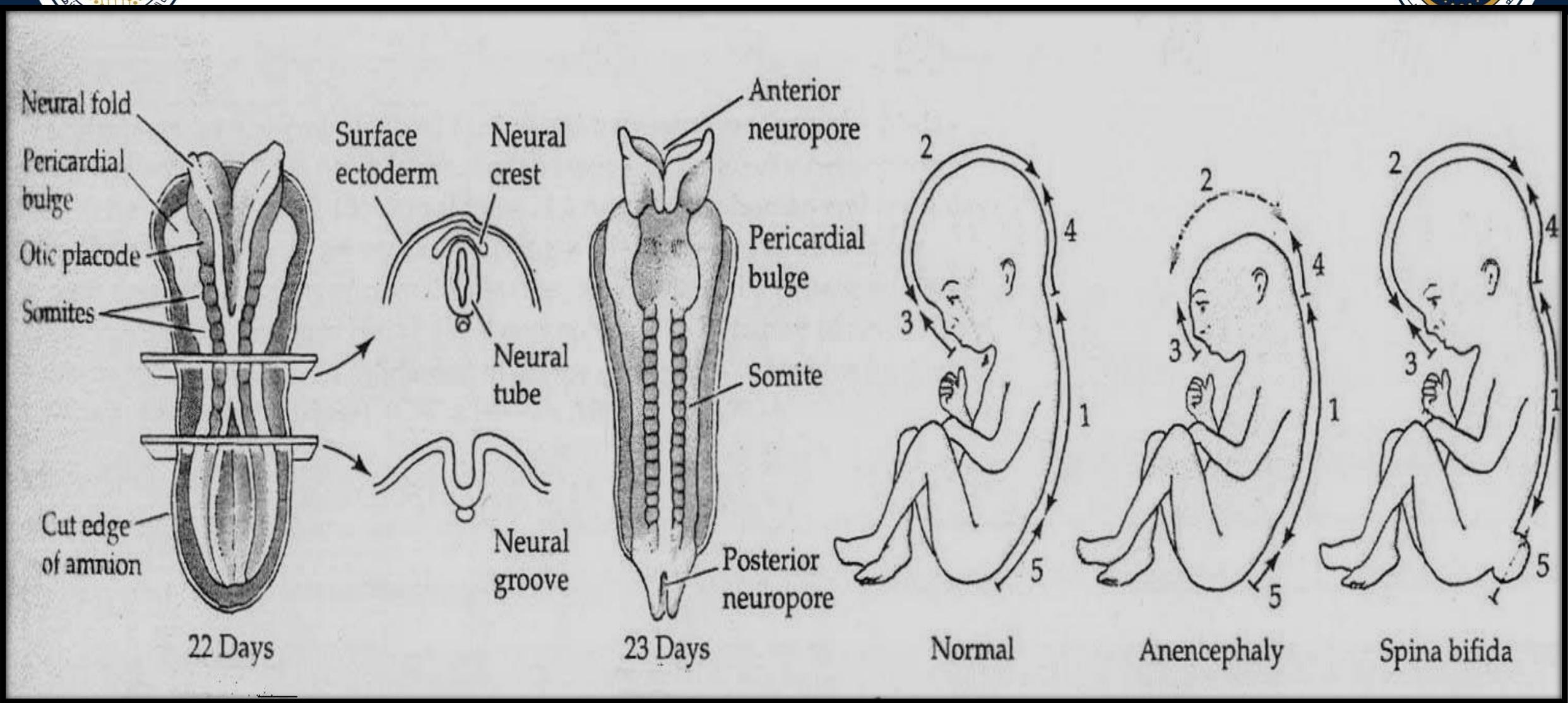




Tuft of hair, related to spina bifida occulta



Congenital dermal sinus



• How can Neural tube defects (NTD) be diagnosed?

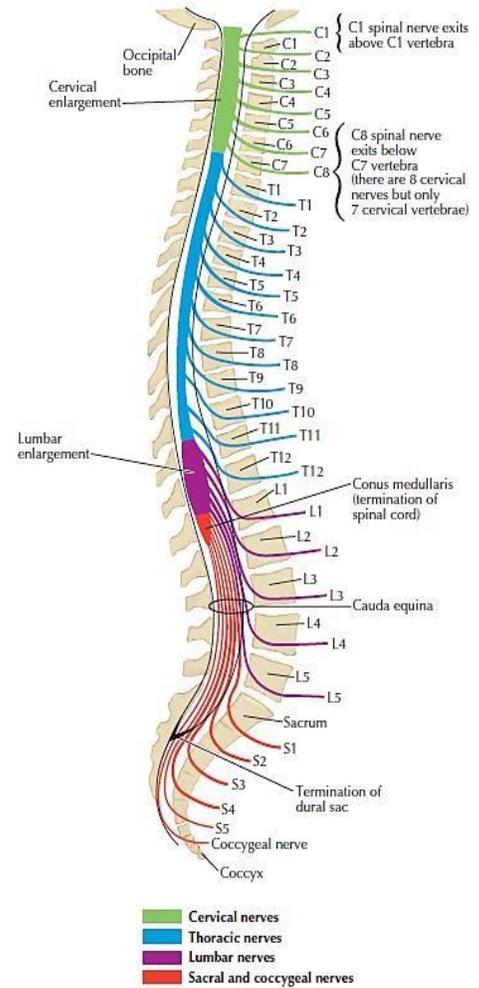
1. Detecting increase in the maternal serum alpha-fetoprotein (AFP).
2. Abdominal ultrasound.

How can you prevent or treat Neural tube defects?

- 70% of cases could be prevented by the use of folic acid during pregnancy.
- Treatment is very expensive with bad prognosis.



SPINAL CORD



Gross anatomy of the spinal cord

- Length: 45 cm in male & 42 cm in female
- Position: upper 2/3 of the vertebral column
- Beginning: at the level of the 1st cervical nerve the foramen magnum as continuation of medulla
- Termination:
 - In adult: at **L1**
 - In newborn: at **L3**
 - In 3rd month intrauterine: **whole length** of the vertebral Canal

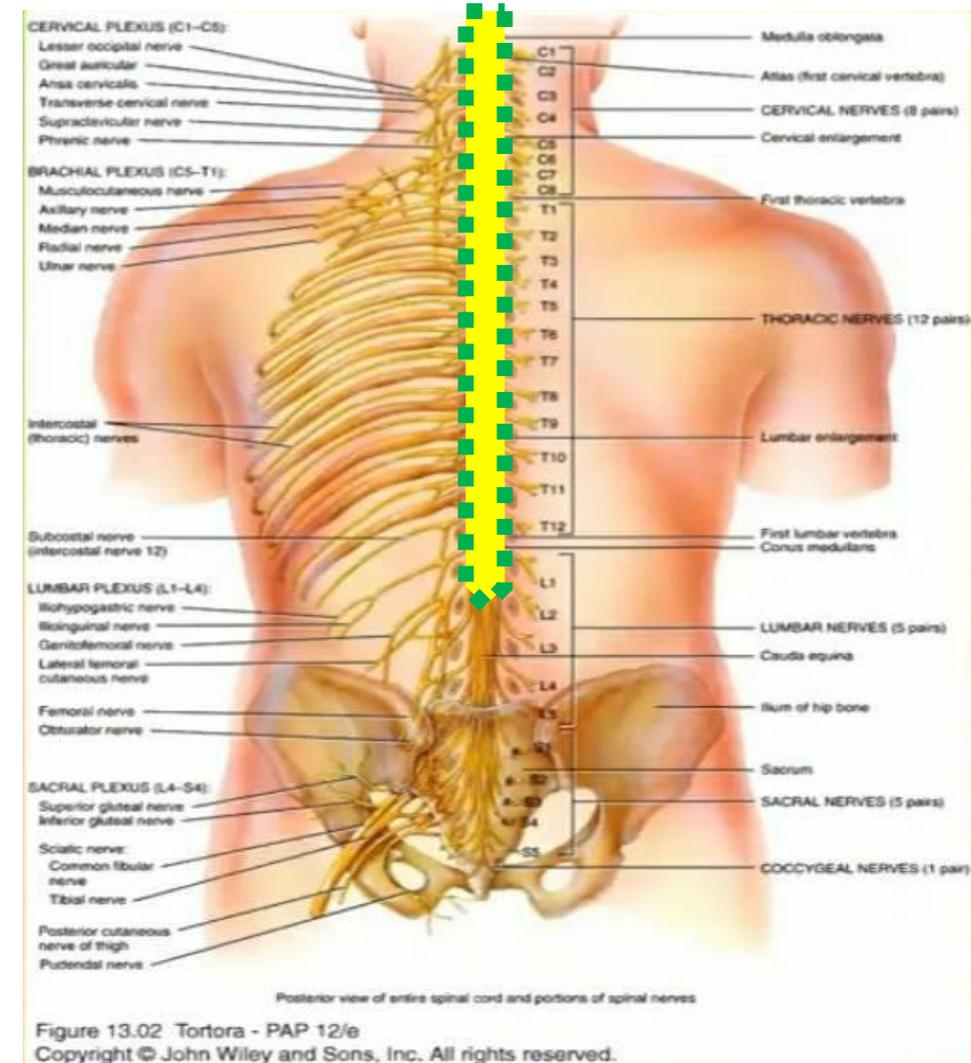


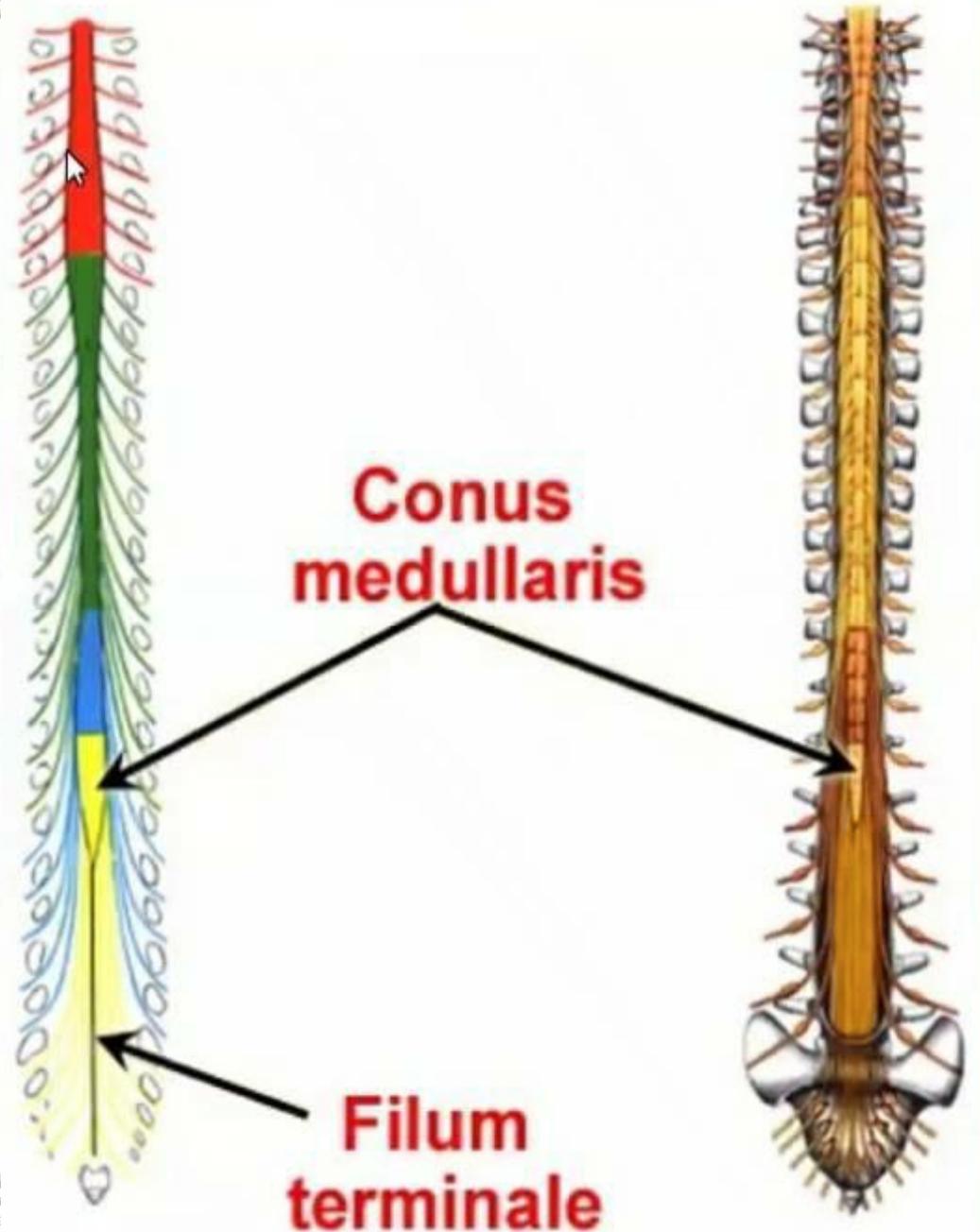
Figure 13.02 Tortora - PAP 12/e
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- **Enlargements:**

A-Cervical: C5 - T1 give the brachial plexus

B-Lumber: L1 – S2 give the lumbosacral plexus

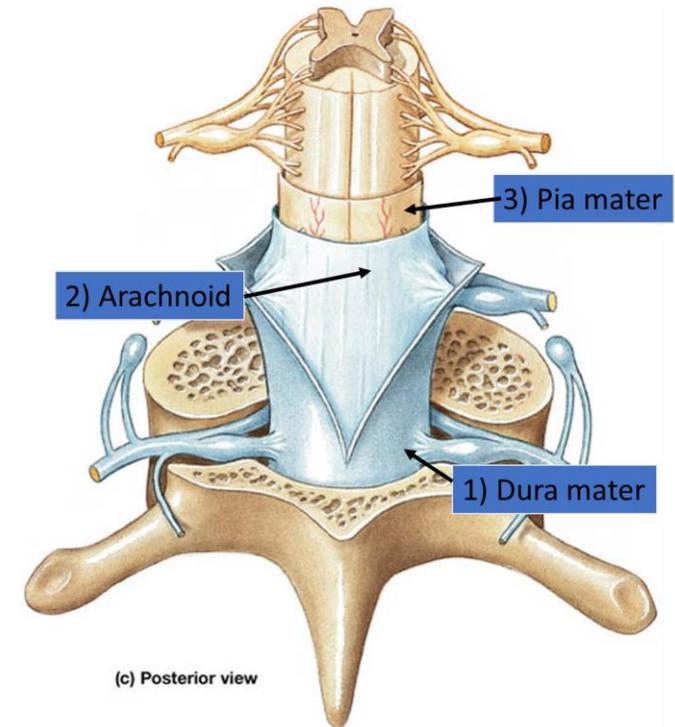
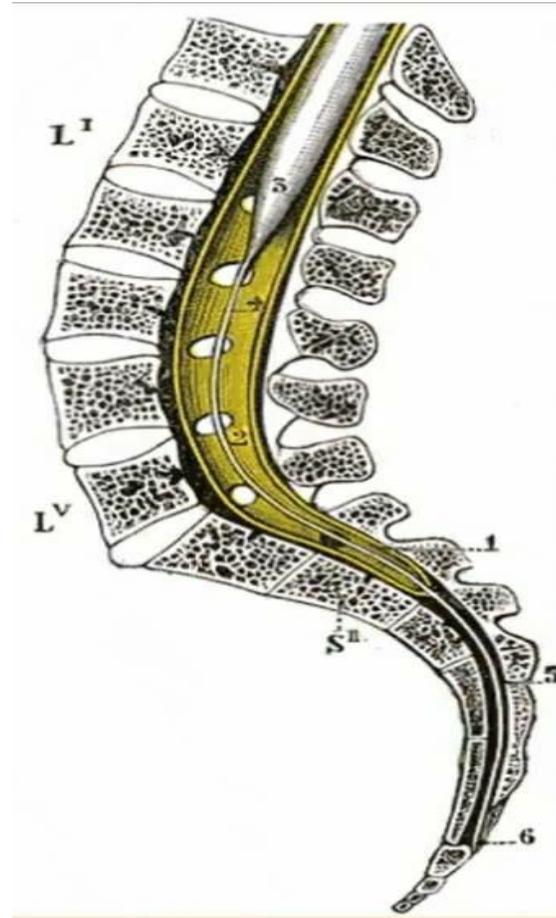
- **Conus medullaris** – lower end of spinal cord
- **Cauda equina** - individual spinal nerves within spinal canal
- **Filum terminale** – pia mater



Protection of the spinal cord

Spinal Meninges

- 1-Dura mater:** end opposite S2
- 2-Arachnoid mater:** end opposite S2
- 3-Pia mater:** form two ligaments which are
 - a-Filum terminale
 - b-Two denticulate ligaments



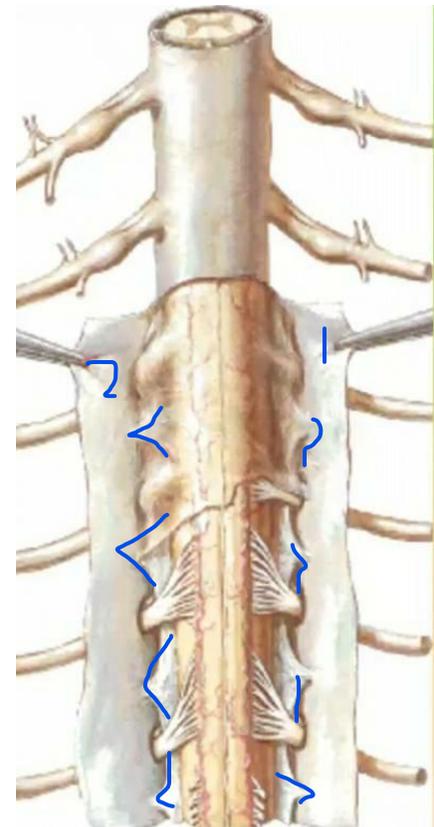
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A-Filum terminale

- Part of **pia mater** that extend from the conus medullaris to the back of the coccyx
- Filum terminale interna: is the part **within** the lumbar cistern
- Filum terminale externa: is the part **outside** the lumbar cistern

B-Two denticulate ligaments

- They extend from the **pia mater** to anchor the spinal cord to the **dura**
- The lateral edge is serrated and has **21 processes** attached to the dura
- Important for spinal support & as a landmark for the spinal cord surgery.**



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Lumber cistern

Definition: sac of subarachnoid space filed with CSF

Extension: from L2 to S2 vertebrae

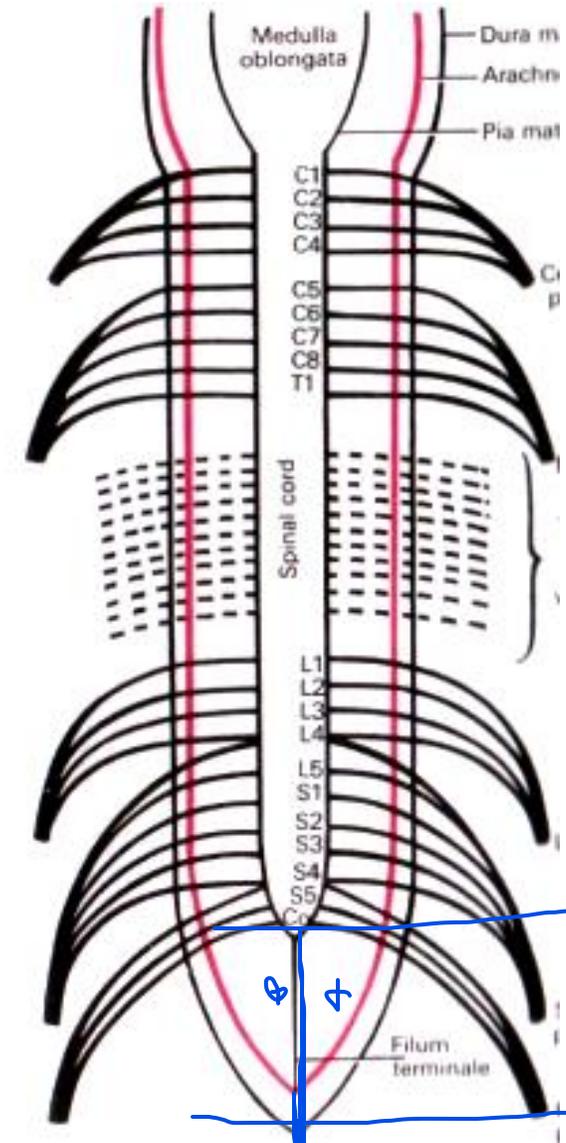
Contents:

1-CSF

2-Cauda equina

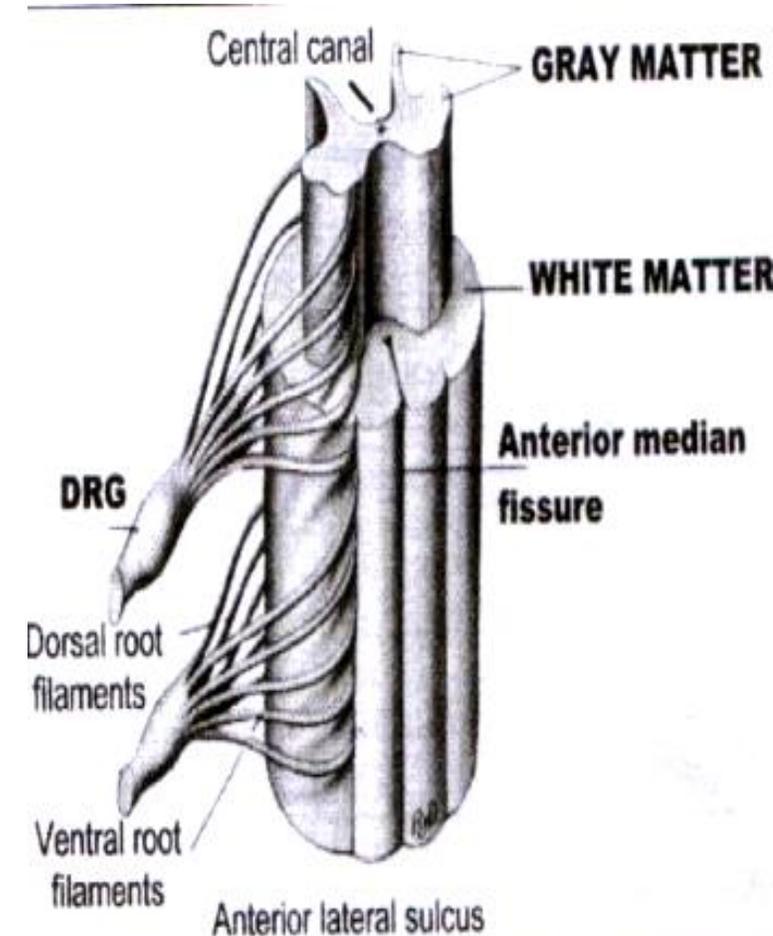
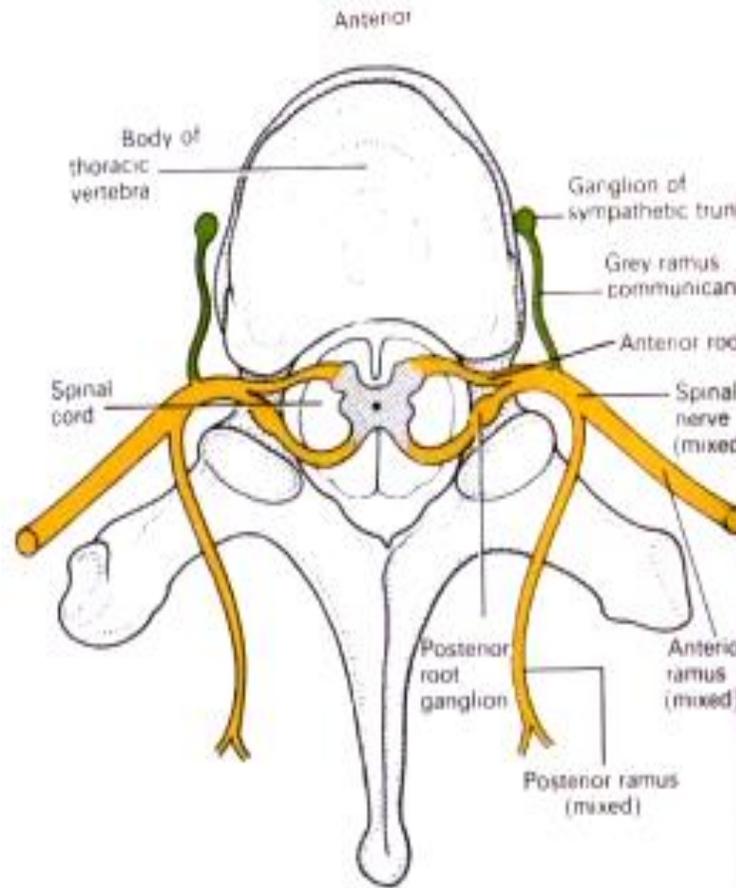
3-Filum terminale interna

Importance: for lumber puncture



Structure of the spinal cord

- The spinal cord has **31 segments** corresponding to the number of the spinal nerves: **8 cervical, 12 thoracic, 5 lumbar, 5 sacral and 1 coccygeal segment.** MCQ
- **Each segment** has a pair of dorsal and ventral nerve roots.
- **The dorsal and ventral roots** join at the intervertebral foramen forming the spinal nerve



STRUCTURE OF THE SPINAL CORD

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Arterial supply of the spinal cord

1-Anterior spinal artery: MCQ

origin: **one** artery from the **vertebral**

distribution: supply the **anterior 2/3** of spinal cord

2-Posterior spinal artery:

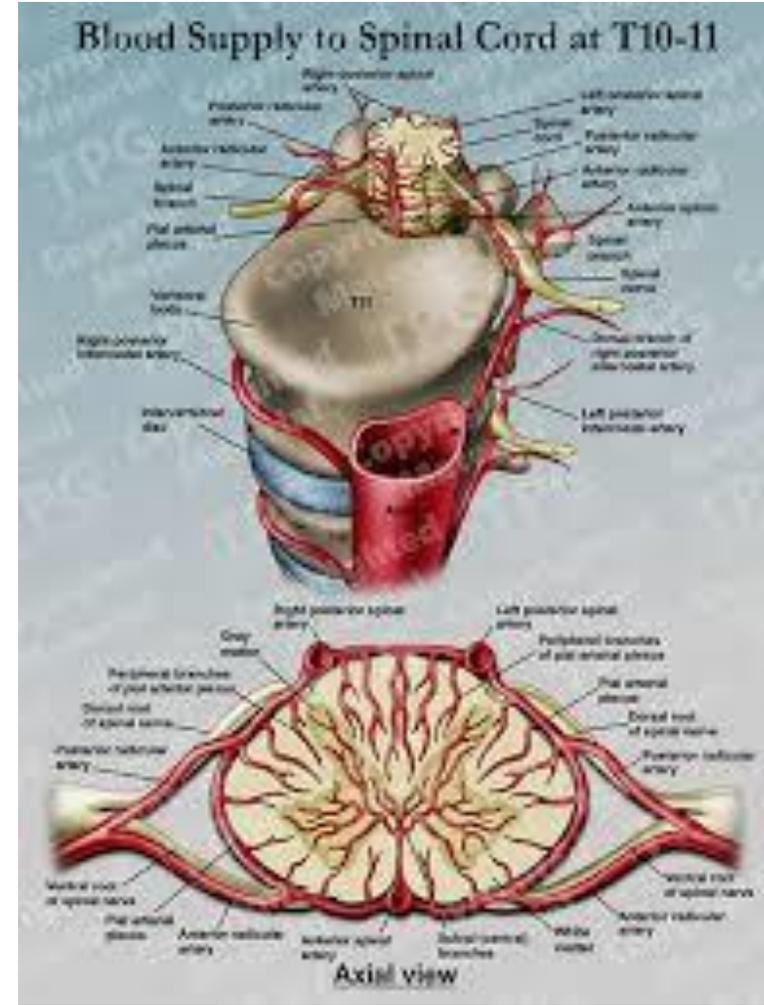
origin: **two** arteries from the **vertebral** MCQ

distribution: supply the **posterior 1/3** of spinal cord

3-Radicular arteries:

origin:

- in the neck: from the vertebral & ascending cervical
- In the thorax: from the intercostal arteries
- In the abdomen: from lumbar arteries
- In the pelvis: from lateral sacral arteries





Development of the brain & External Features of the Brain Stem

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The nervous system

The Nervous System is divided into two parts:

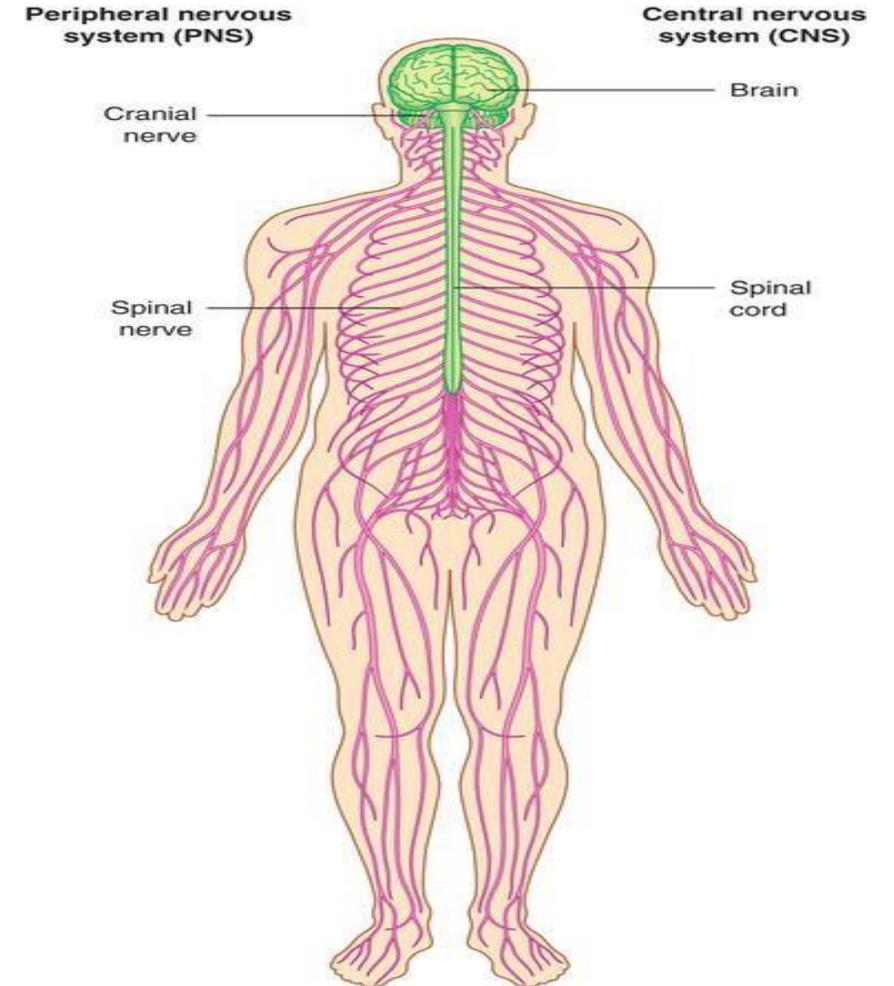
1- The Central Nervous System(CNS) (brain and spinal cord).

2- The Peripheral Nervous System(PNS) (Nerves :**12 Pairs** of Cranial &**31 pairs** of Spinal Nerves+ associated Ganglia).

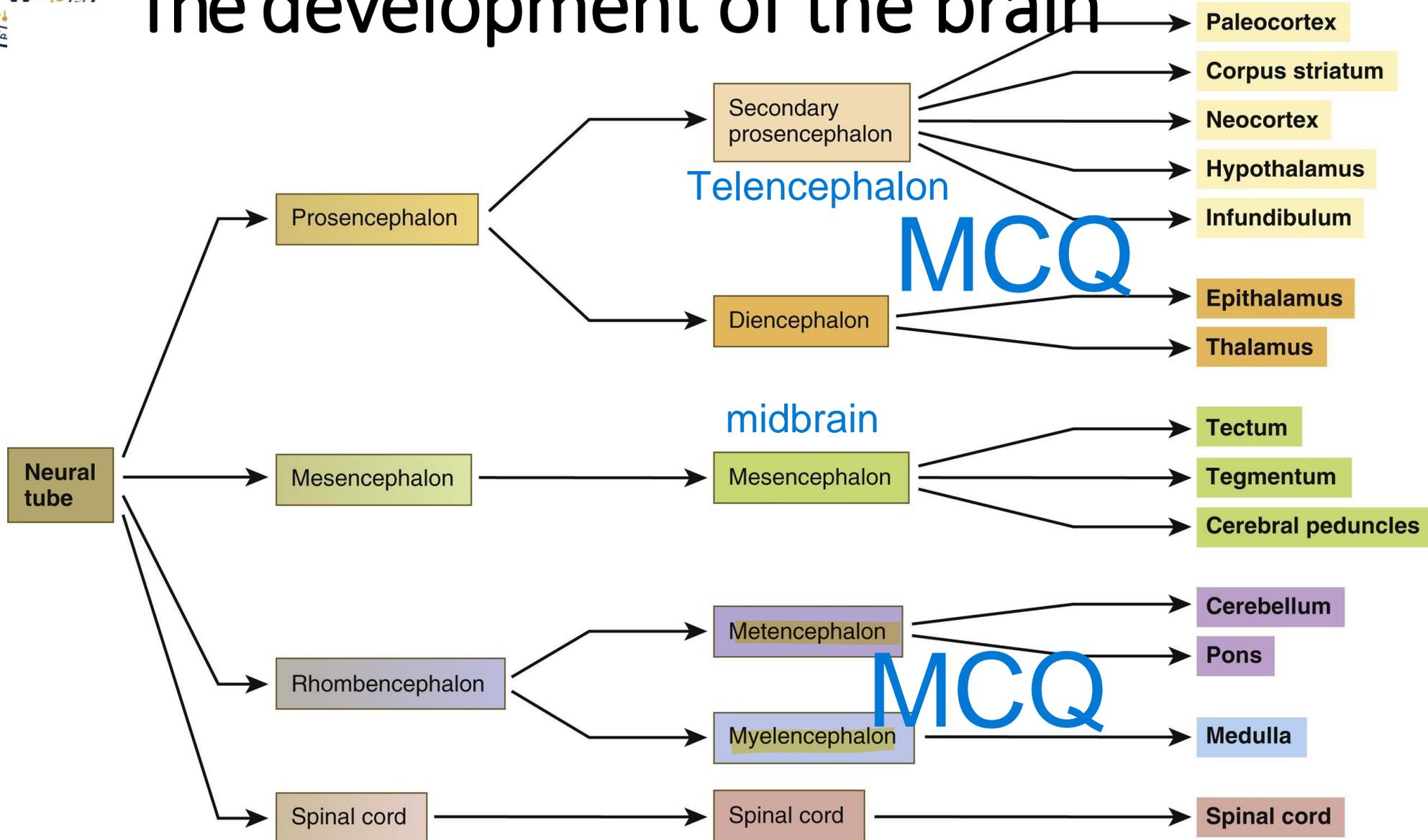
Functionally, the **Nervous System** can subdivide into:

A- Somatic Nervous System, which control on voluntary activities.

B- Autonomic Nervous System, control on involuntary activities.



The development of the brain

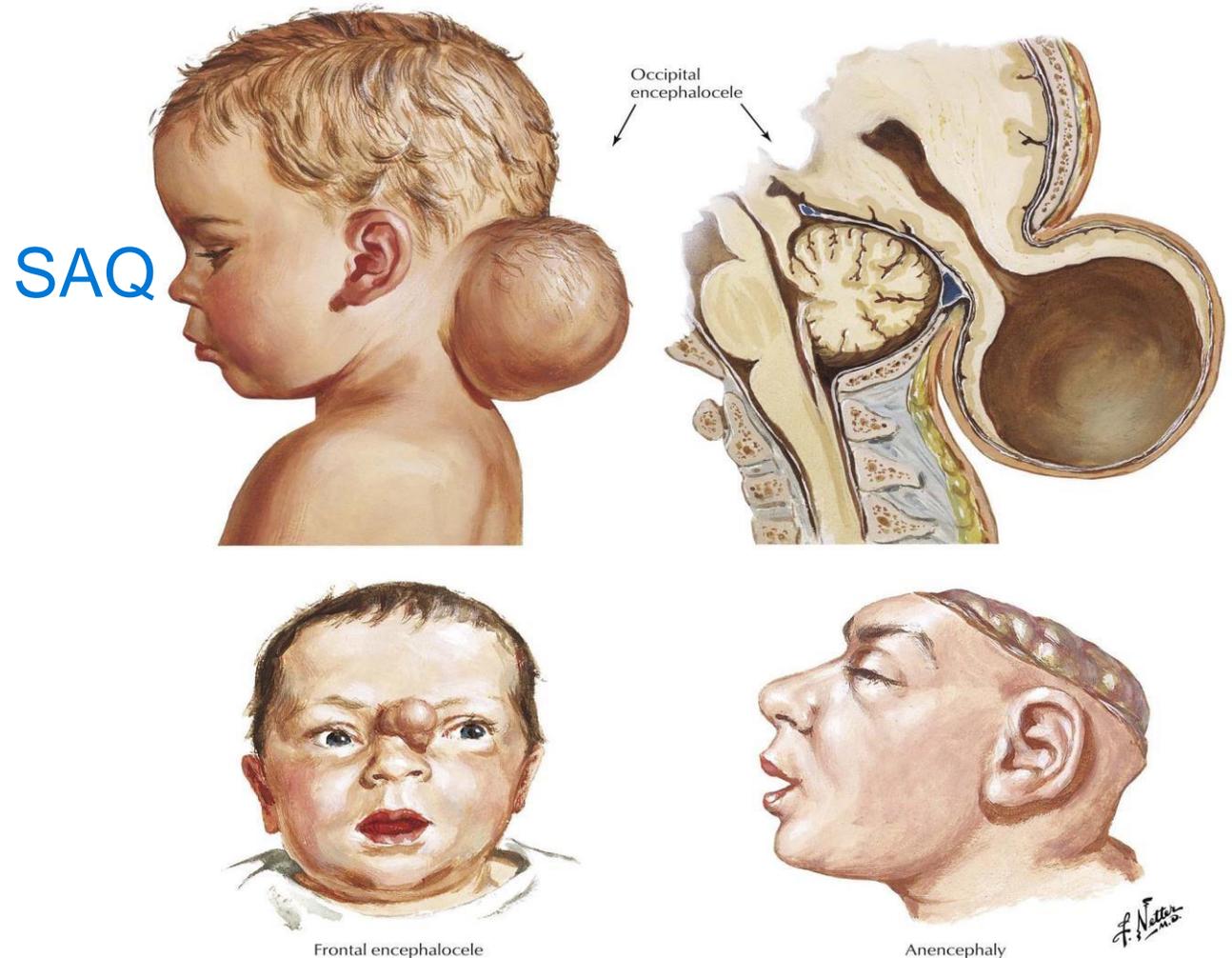


MCQ

MCQ

The Congenital Anomalies of the Brain

- ❑ Defects of the brain are common, approximately **3 per 1000 births**. Most major birth defects, such as anencephaly and meningoencephalocele, result from **defective closure of the rostral neuropore** (neural tube defects [NTDs]) during the **fourth week** of development and involve the overlying tissues (meninges and calvaria).
- ❑ The factors causing NTDs are genetic, nutritional, and/or environmental in nature
- ❑ **ANENCEPHALY** is a severe birth defect of the calvaria that results from failure of the rostral neuropore to close during the **fourth week**.
- ❑ As a result, the forebrain, midbrain, most of the hindbrain, and the calvaria are absent.
anencephaly is a common lethal defect, occurring at least **once in every 1000 births**.



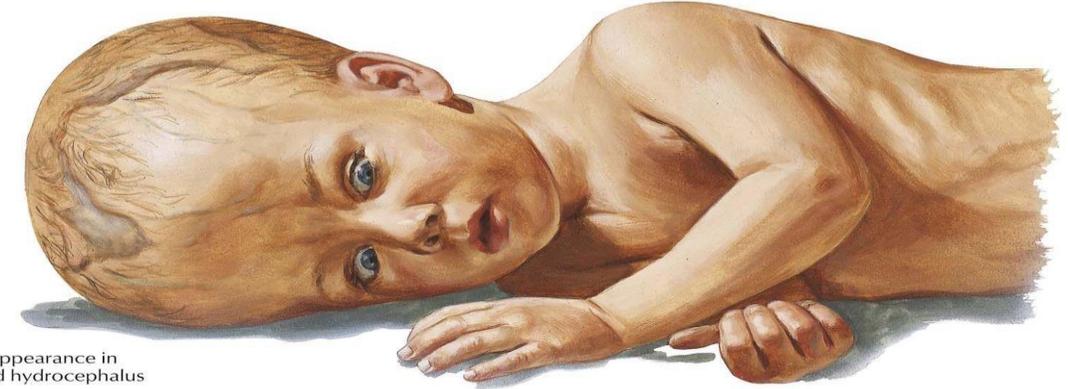
The Congenital Anomalies of the Brain

Hydrocephalus

An infant with hydrocephalus has a significant enlargement of the head, but the face is of normal size. Usually, this defect is associated with mental deficiency.

- ❑ Hydrocephalus results from impaired circulation and absorption of CSF or, in unusual cases, from increased production of CSF. An excess of CSF is present in the ventricular system of the brain.
- ❑ Impaired circulation of CSF often results from congenital aqueductal stenosis (narrow cerebral aqueduct).
- ❑ Blockage of CSF circulation results in dilation of the ventricles proximal to the obstruction and increased pressure on the cerebral hemisphere.

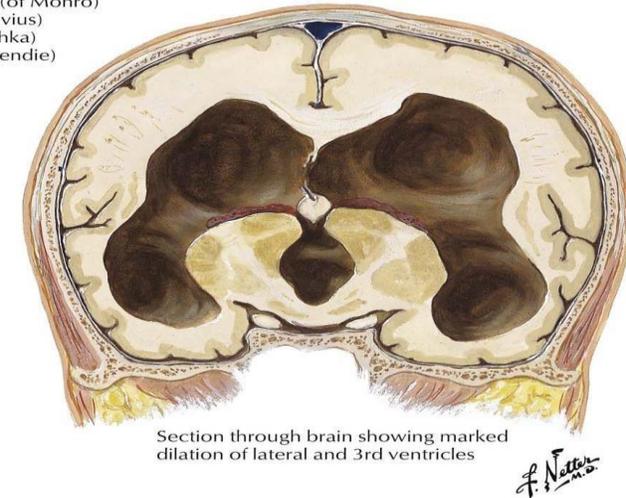
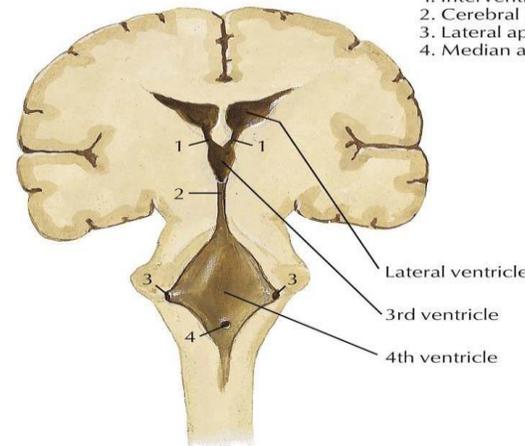
Hydrocephalus



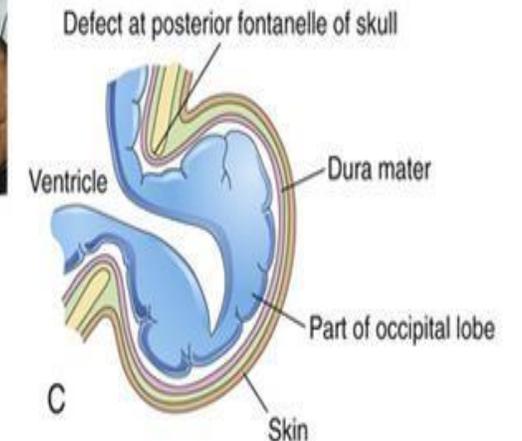
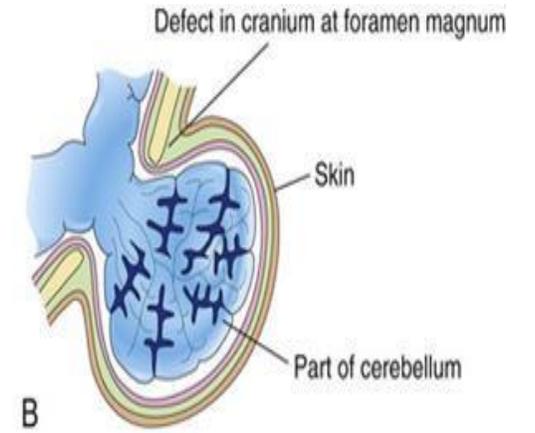
Clinical appearance in advanced hydrocephalus

Potential lesion sites in obstructive hydrocephalus

1. Interventricular foramina (of Monro)
2. Cerebral aqueduct (of Sylvius)
3. Lateral apertures (of Luschka)
4. Median aperture (of Magendie)



The Congenital Anomalies of the Brain



External features of the brain stem

Medulla oblongata

The medulla is the lower part of the brainstem and continues downwards as the spinal cord. 3cm in long

Features of the ventral surface

3 Elevations: Pyramid: contains the corticospinal tract.

Olive: oval elevation formed by the underlying inferior olivary nucleus.

Inferior cerebellar peduncle: it connects the medulla with the cerebellum.

on each side of the midline. From the **medial to the lateral side:**

3 Fissures:

Anterior median sulcus: in the midline.

Preolivary fissure: between the pyramid and olive.

Postolivary fissure: between the olive and inferior cerebellar peduncle.

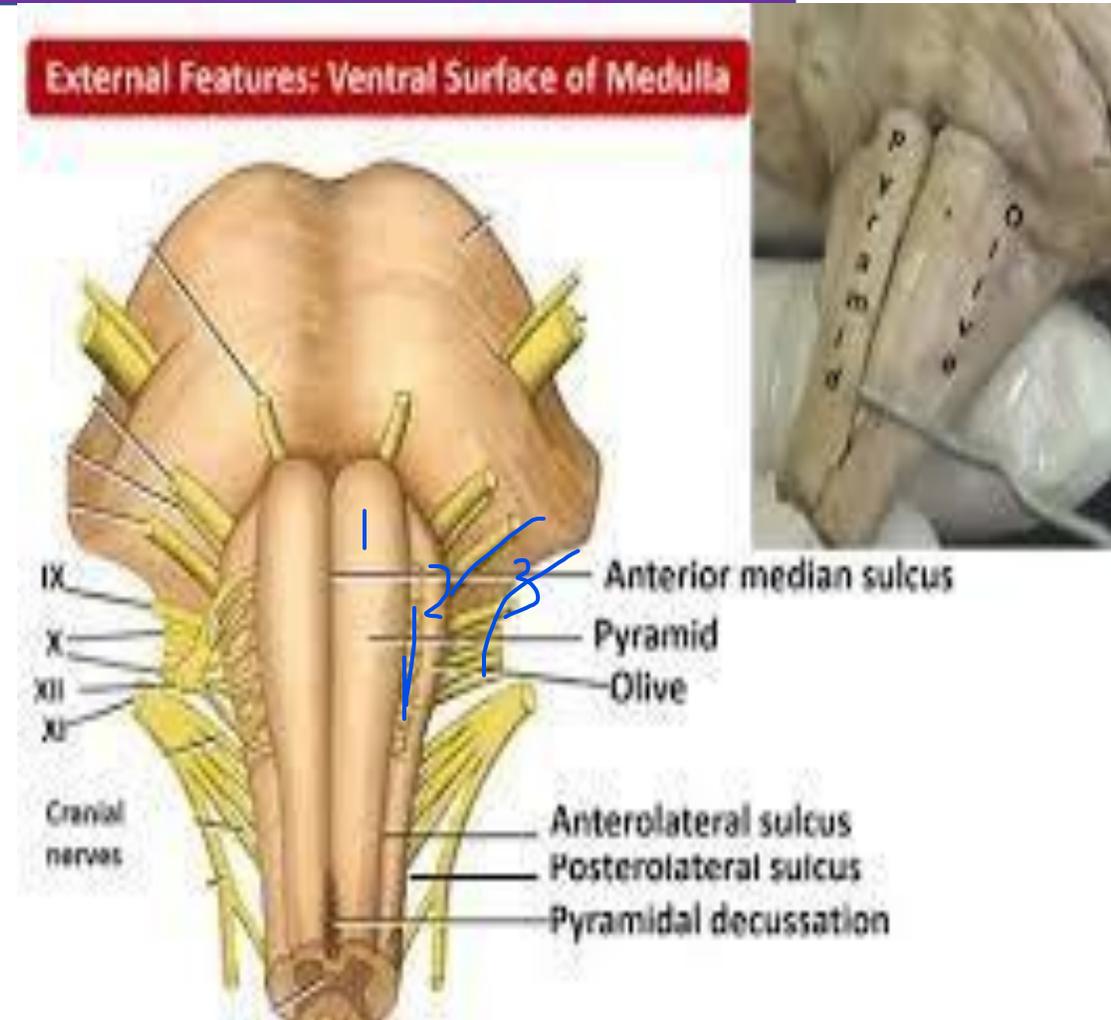
Exit of the last 4 cranial nerves:

Glossopharyngeal, vagus and cranial accessory nerves: in the post-olivary fissure.

Hypoglossal nerve: exits in the preolivary fissure.

SAQ

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Features of the dorsal surface of medulla oblongata

Lower part of the medulla: it shows **3 elevations** on each side of the midline:

Gracile tubercle (clava): medial and formed by the gracile nucleus.

Cuneate tubercle: middle and formed by the cuneate nucleus.

Tuberculum cinereum: lateral and formed by the spinal trigeminal nucleus.

Upper part of the medulla: lower part of the **floor of the 4th ventricle**

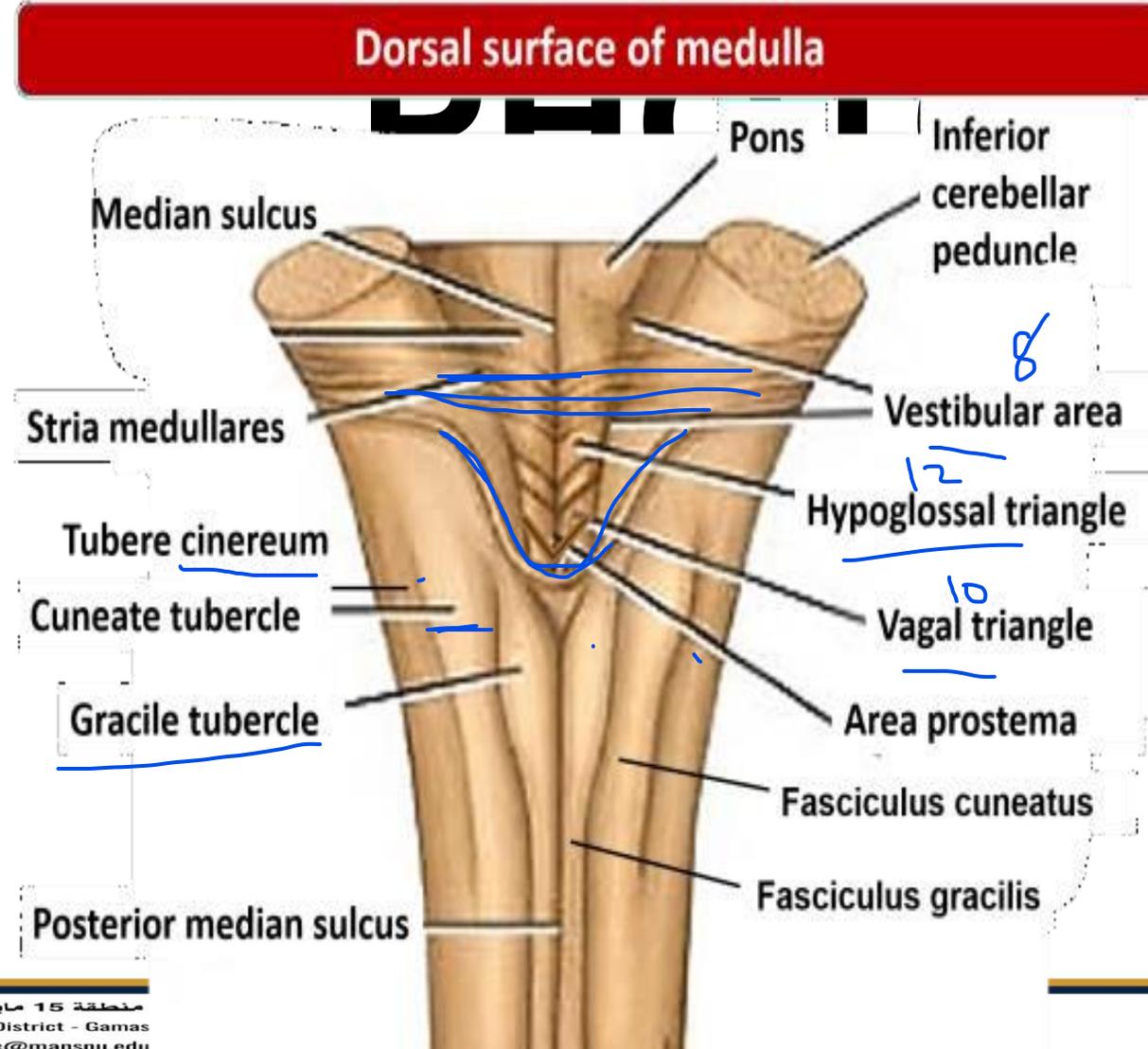
It is divided into 3 trigones by sulcus limitans (**inferior fovea**): **Hypoglossal trigone:** medial, formed by the hypoglossal nucleus.

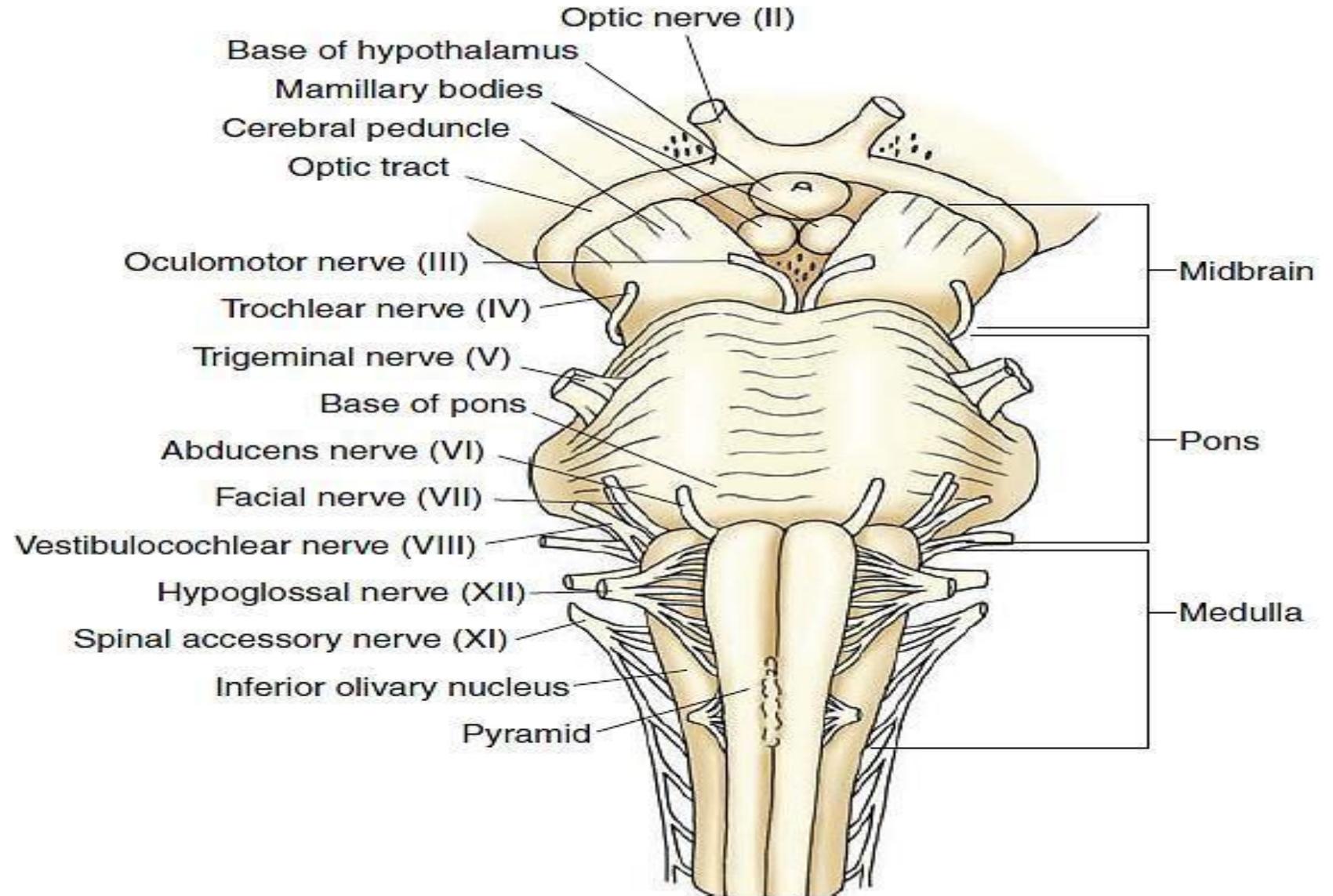
Vagal trigone: middle, formed by the dorsal motor nucleus of the vagus. **SAQ**

Vestibular trigone: lateral, formed by the medial & inferior vestibular nuclei.

Area postrema (vomiting center): at the lower angle of the 4th ventricle (obex).

Stria medullaris of the 4th ventricle: band of fibers at the upper end of the medulla





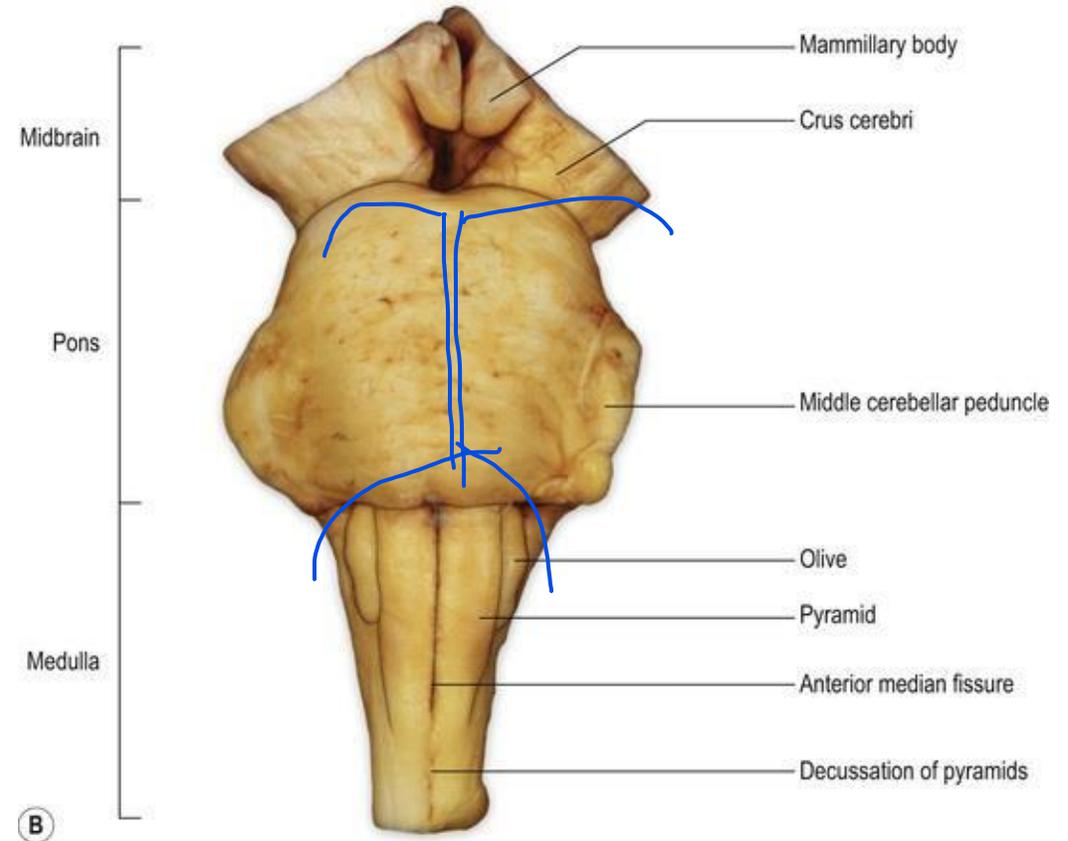
Features of The ventral surface of the Pons

- ❑ **The pons** is the middle part of the brainstem.
- ❑ It lies between the midbrain and medulla.
- ❑ It is divided into anterior part called **basis pontis** and posterior part called **tegmentum**.

Features Of The Ventral Surface

A- Basilar groove: in the middle. It lodges the basilar artery.

B- Transverse pontine fibers: they form the middle cerebellar peduncle, which connects the pons with the cerebellum.



External Features Of The Pons

C- Exit Of The Middle Four Cranial Nerves:

Trigeminal nerve: exits midway between the upper and lower borders of the pons near the middle cerebellar peduncle.

Abducent nerve: exits in the groove between the pyramid and the pons.

Facial nerve: exits in the cerebellopontine angle. It consists of 2 roots: **Medial motor root: is large**

Lateral sensory root: is small and called nervus intermedius.

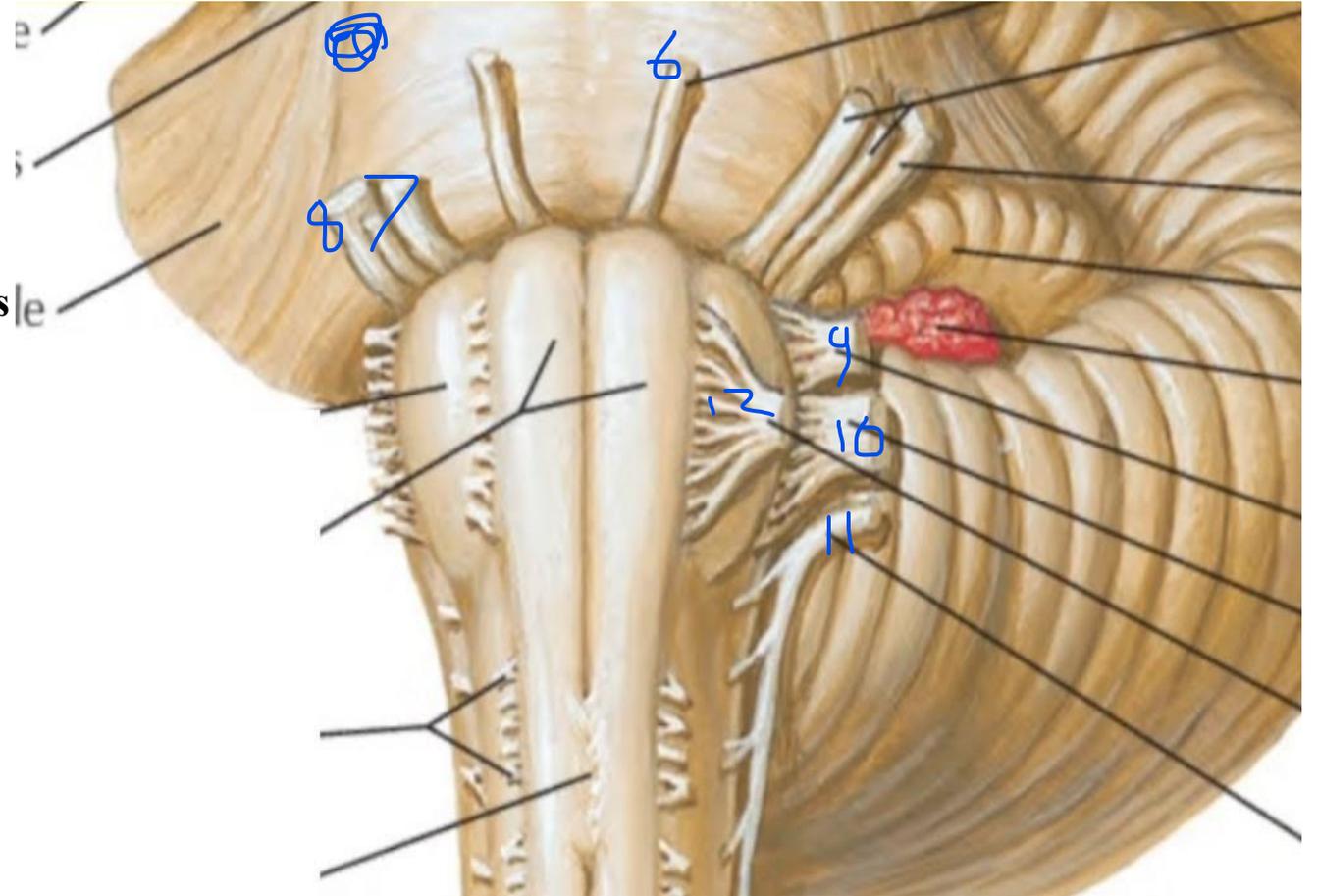
Vestibulocochlear nerve: exits in the cerebellopontine angle lateral to the facial nerve.

D- Cerebellopontine Angle: junction of the medulla, pons and cerebellum. It contains:

Cranial nerves: facial, vestibulocochlear, and glossopharyngeal nerves.

Lateral recess and foramen of luscka of the 4th ventricle.

Choroid plexus of the 4th ventricle protruding into foramen of luscka. **Aica** (anterior inferior cerebellar artery).



Features of the dorsal surface of the pons

❑ It forms the upper part of the floor of **the 4th ventricle.**

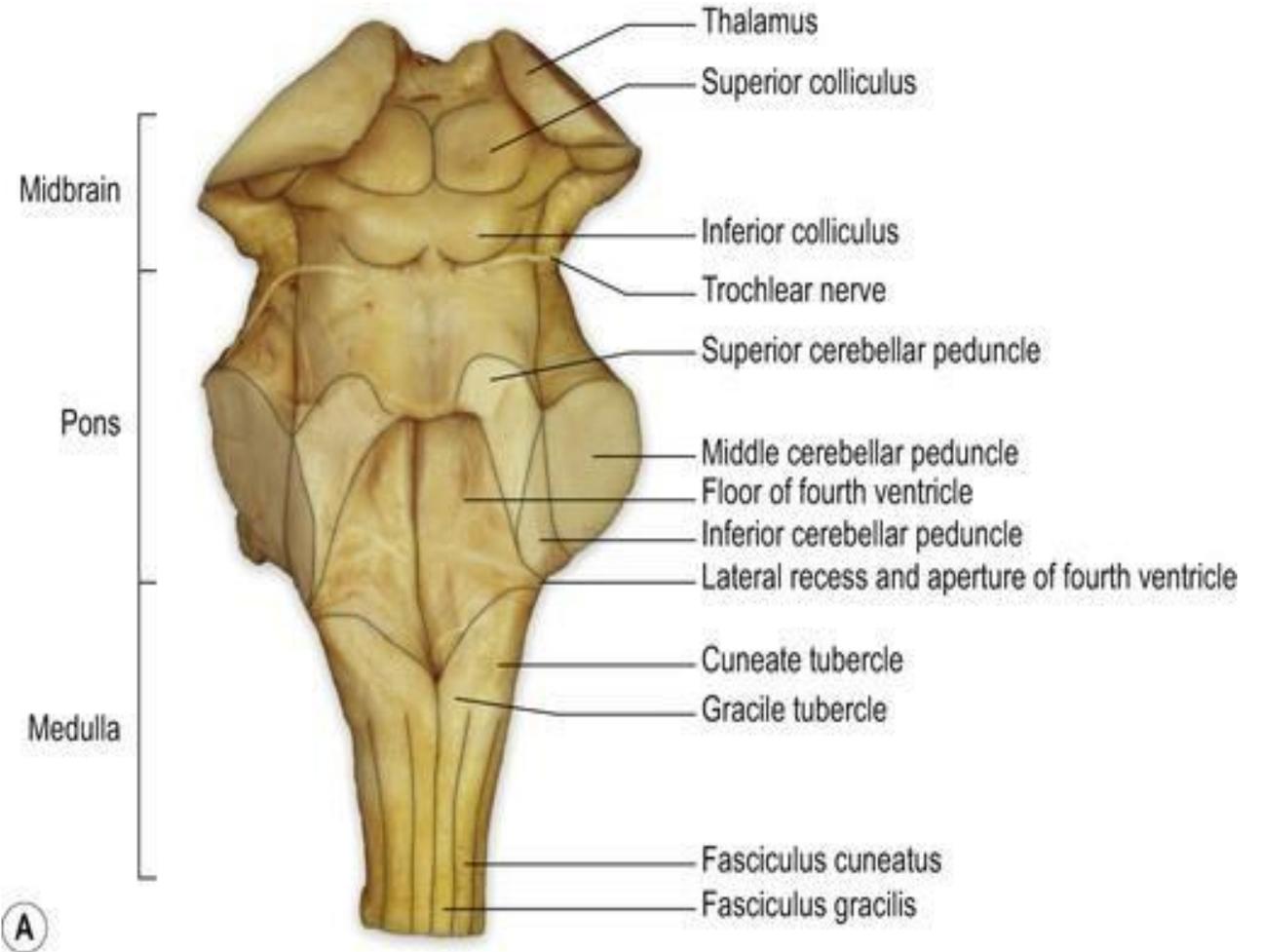
It is bounded on each side by the **superior cerebellar peduncle.**

It contains:

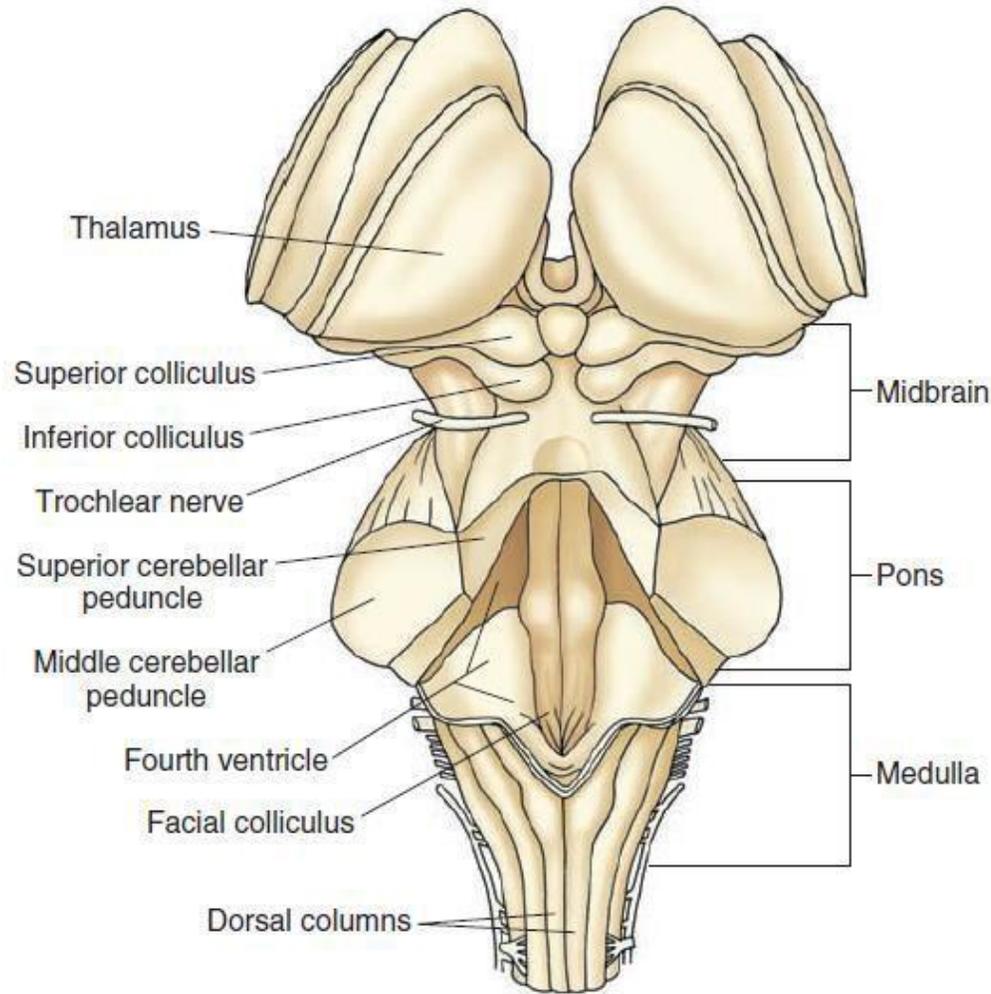
1-Medial eminence: medial. It contains the facial colliculus at its lower end, which is produced by the abducent nucleus and the encircling facial nerve fibers.

2- Sulcus limitans (superior fovea): middle. It contains a small, pigmented area at its upper end called **locus ceruleus**, which is a noradrenaline-secreting center.

3- Vestibular area: lateral. It is produced by the superior and lateral vestibular nuclei.



A



Features of the dorsal surface (tectum)

❑ **Four Colliculi (Corpora Quadrigemina):**

are 4 rounded elevations:

❑ **Two superior colliculi:** Are **visual reflex centers.**

MCQ

Are connected with the **lateral geniculate body** by the **superior brachium.**

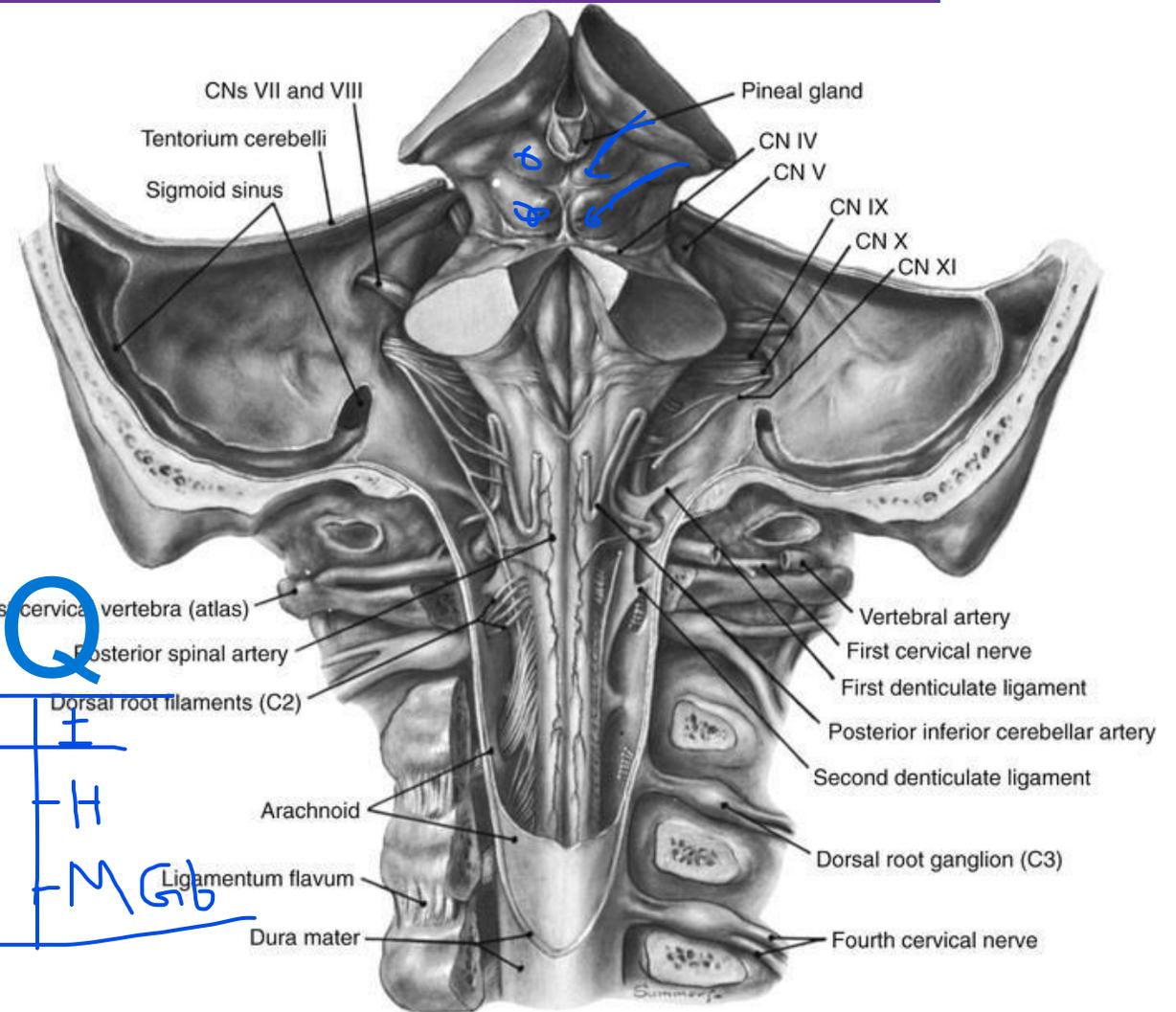
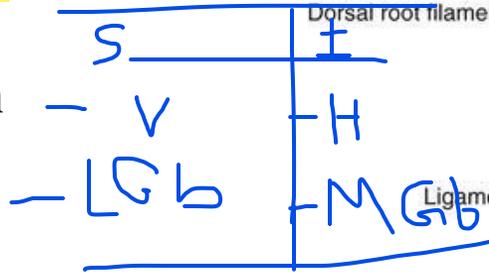
❑ **Two inferior colliculi:** Are **auditory reflex centers.**

MCQ

Are connected with the **medial geniculate body** by the **inferior brachium.**

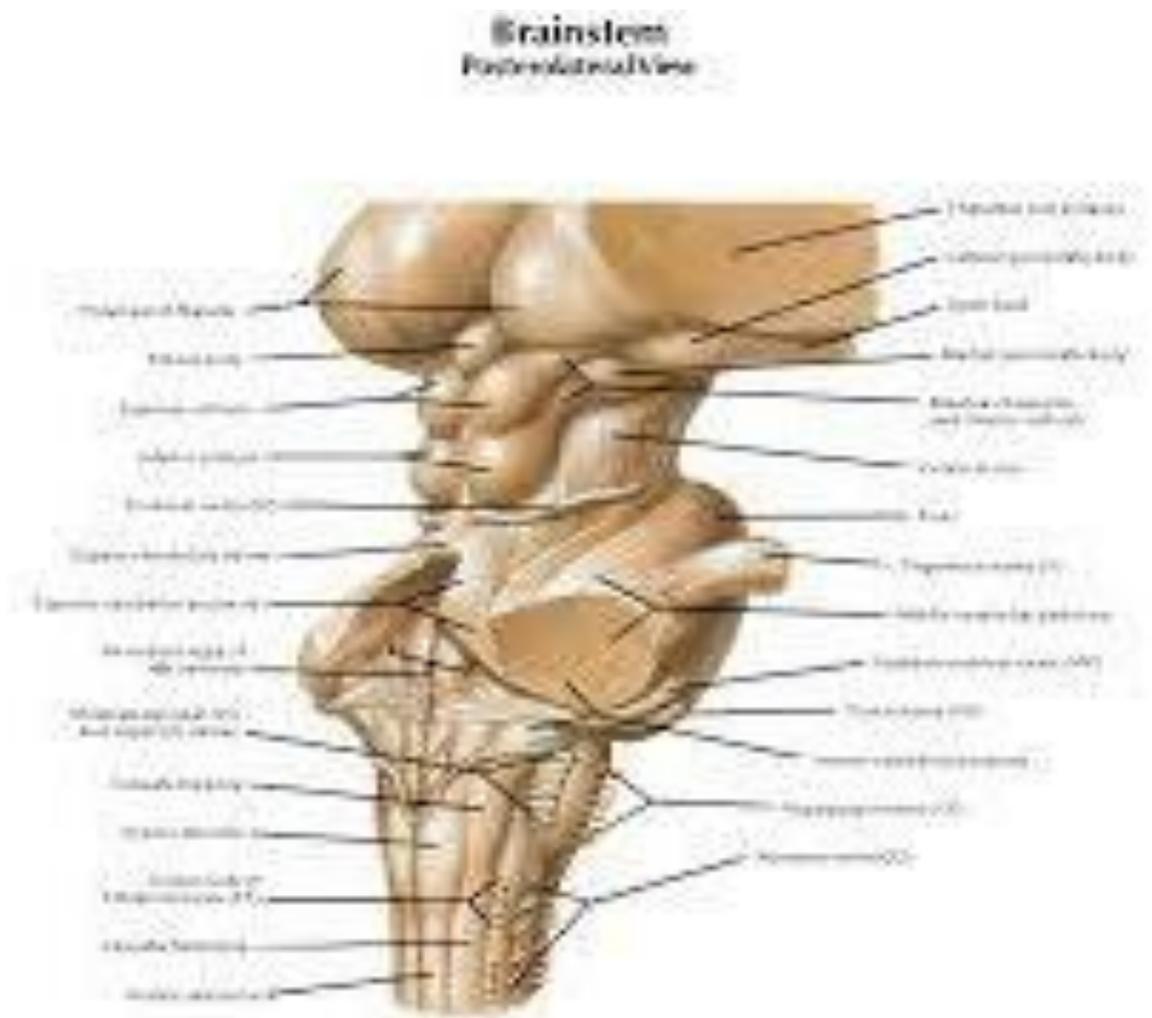
❑ **Trochlear nerve:** exits from the tectum just below the inferior colliculus.

SAQ



Features Of the Lateral Surface of Midbrain

- ❑ **Superior brachium (brachium of the superior colliculus):** connects the superior colliculus with the optic tract and the **lateral geniculate** body (part of the thalamus).
- ❑ **Inferior brachium (brachium of the inferior colliculus):** connects the inferior colliculus with the **medial geniculate body** (part of the thalamus).
- ❑ It is related to **5 structures around the crus cerebri: 2 arteries, 2 nerves, 1 vein**
 - 1 Posterior cerebral artery.
 - 2 Superior cerebellar artery.
 - 3 Trochlear nerve.
 - 4 Optic tract.
 - 5 Basal vein (**Rosenthal's vein**).





Internal features of Brain stem (medulla & pons)

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By

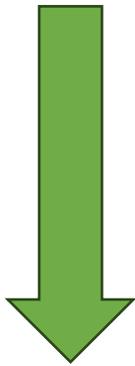
Dr. Fekry Shata





Internal Features of Medulla

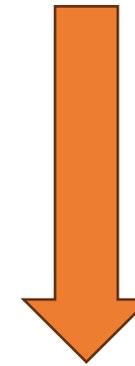
Nuclear Groups Present In Medulla



Gracile & Cuneate



Cerebellar Relay Nuclei



Cranial Nerve Nuclei



Gracile & Cuneate

Input

- They receive **gracile and cuneate tracts**.
- They receive sensory information for **kinesthesia (sense of movement), discriminative touch and vibration** from the same side of the body.

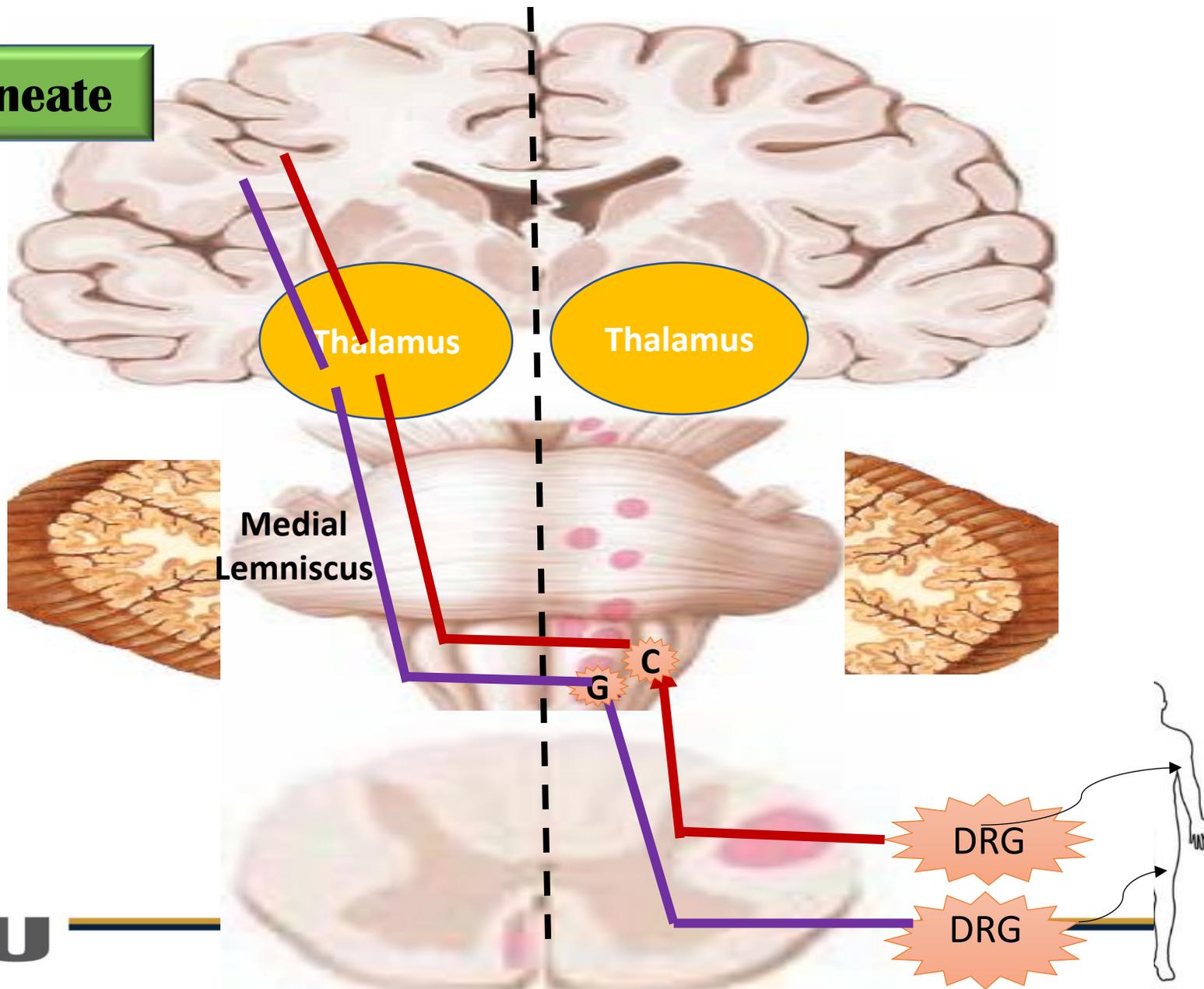
MCQ

Output

- They contain the **2nd order neuron**; their axons form the **internal arcuate fibers** which cross to the opposite side in the sensory decussation which form the **medial lemniscus**.

MCQ

Gracile & Cuneate



Cerebellar Relay Nuclei

1- Accessory cuneate:

Site: Lateral to cuneate nucleus.

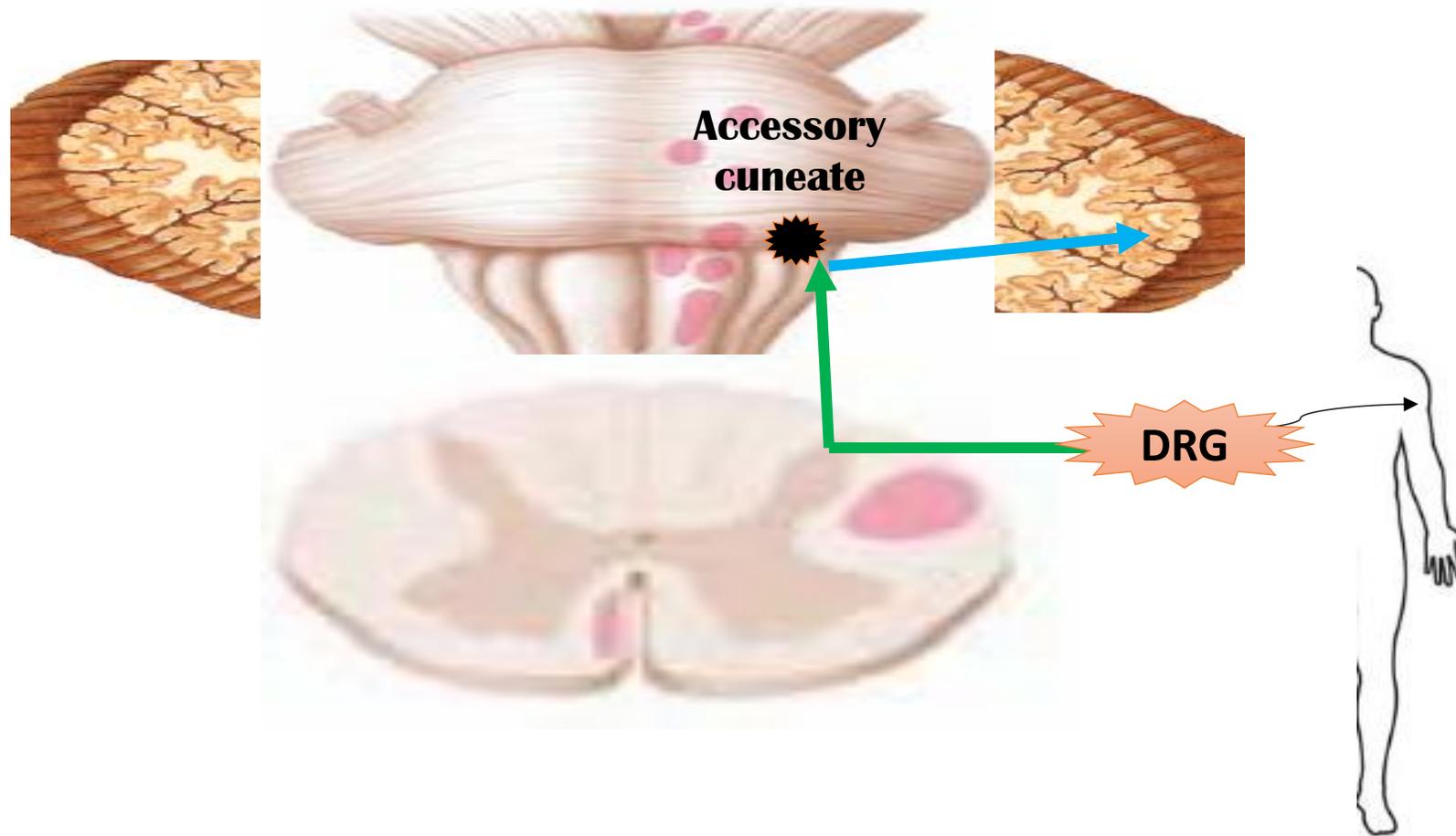
Input:

It receive **proprioceptive** information from the upper limb.

Output:

Its axons form **cuneocerebellar tract** (dorsal external arcuate fibers), which reaches the cerebellum through the **inferior cerebellar peduncle**.

1- Accessory cuneate:



2- Inferior Olivary Nucleus

Formed of 3 groups: **inferior** , **medial** and **dorsal**

Input:

- **Sensory** data from spinal cord via **spino-olivary** tract.
- **Motor** data from cerebral cortex via **coricospinal** tract.
- **Motor** data from basal ganglia & red nucleus via **central tegmental tract**.

Output:

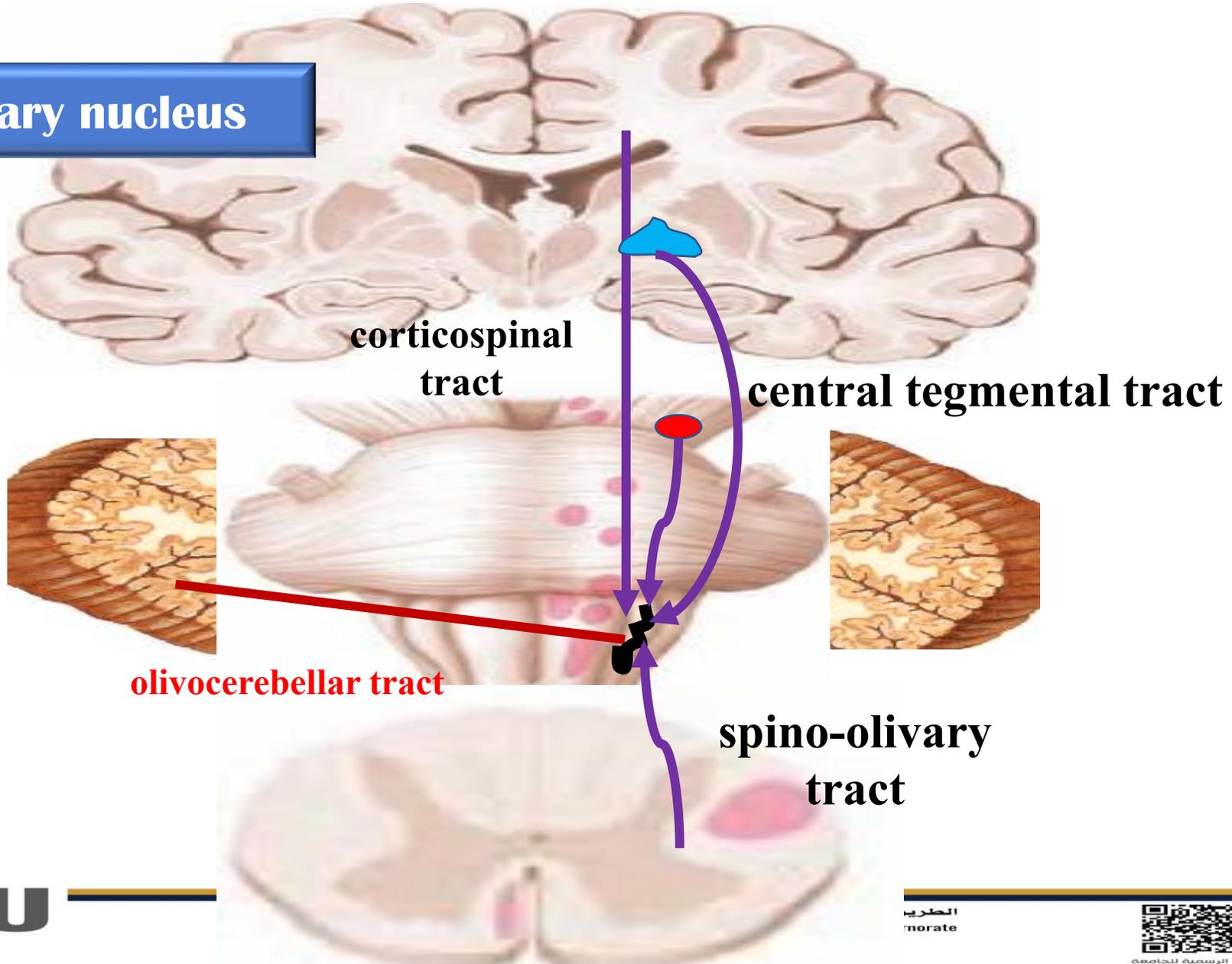
Axons form **olivocerebellar tract** which cross to opposite side and enter the cerebellum through the **inferior cerebellar peduncle**.

Function: Cerebellar control of movement.

Lesion: Cerebellar ataxia.



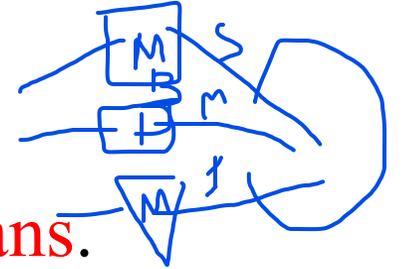
2- Inferior olivary nucleus



3- Reticular formation

Input:

- Receives **motor** data from the **motor areas of the cerebral cortex**.
- Receives **sensory** data from the **spinal cord and special sense organs**.



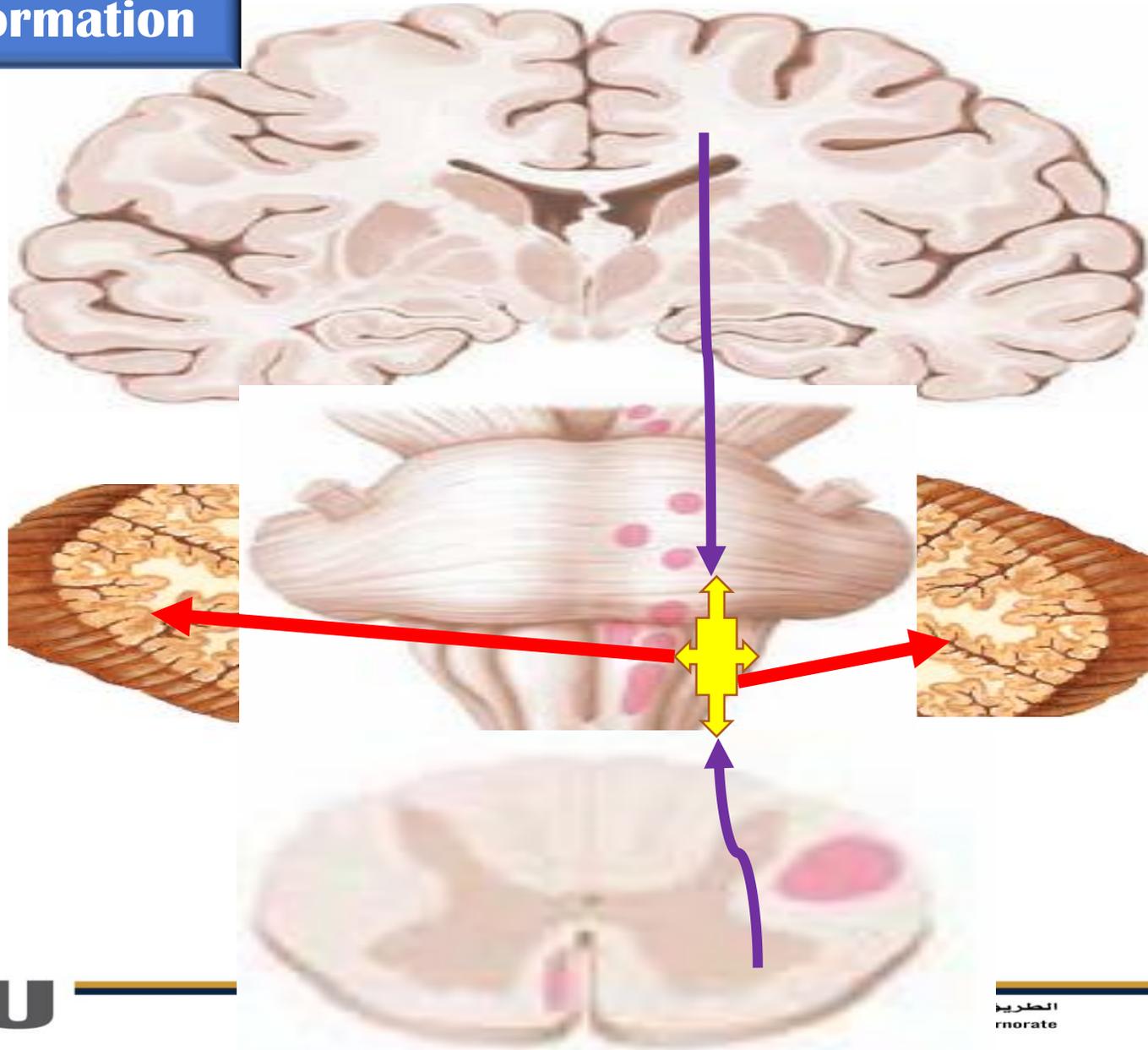
Output:

- It projects these data **to the cerebellum** through the **inferior cerebellar peduncle**

Function:

- It Reticular Activating System (**RAS**): responsible for the electrical activity of the cerebral cortex. It is important for **alertness & arousal from sleep**.
- **Motor** Function: it influences the **muscle tone**. The medullary and pontine reticulospinal tracts facilitate the flexor and extensor muscles, respectively.
- **Autonomic** Function: it contains **respiratory and cardiovascular centers**.

3- Reticular formation



4- Arcuate nucleus

Site: ventral to the pyramid.

Input: receives fibers from the cerebral cortex via pyramidal tract.

Output:

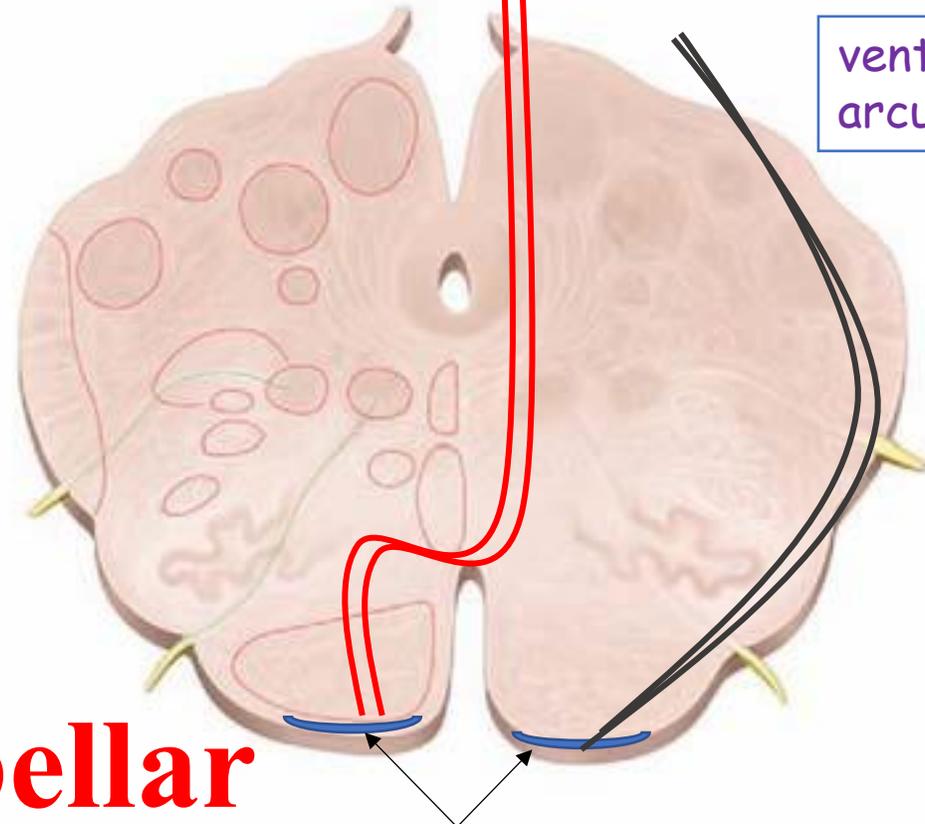
The axons form **arcatocerebellar fibers**, reach the cerebellum through the **ICP** by 2 routes:

A- Ventral external arcuate fibers: to the cerebellum from the same side.

B- Stria medullaris of the 4th ventricle: to the cerebellum from the opposite side.

stria medullaris of
the 4th ventricle

ventral external
arcuate fibers

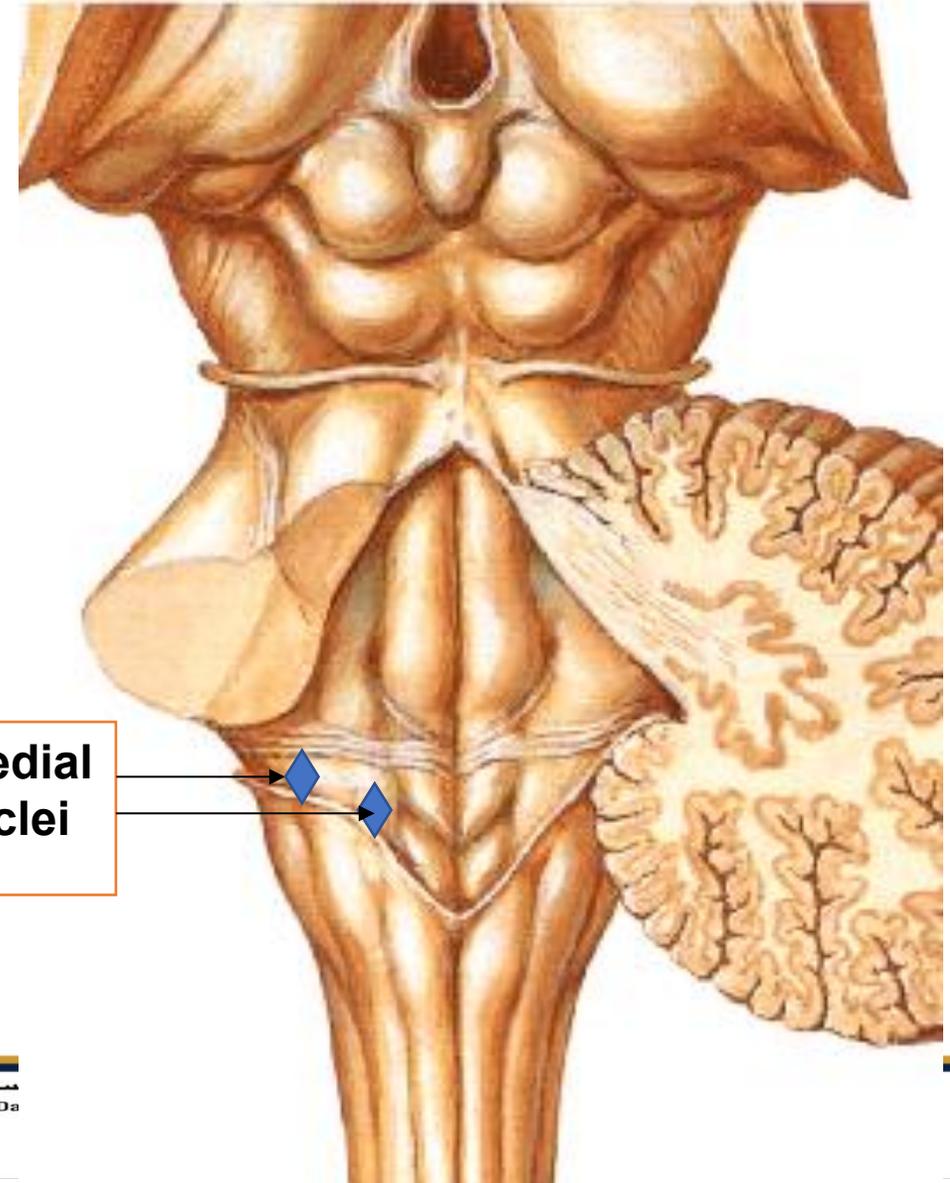


Arcuate nucleus

Arcuatocerebellar fibers

5- Vestibular nuclei

- They project **vestibulocerebellar** fibers by 2 routes:
 1. Direct: from the vestibular **nerve**.
 2. Indirect: from the vestibular **nuclei**



Inferior and Medial Vestibular nuclei

Cranial Nerve Nuclei

SAQ

Eight nuclei for cranial nerves:

Two sensory:

spinal nucleus of trigeminal and nucleus solitariae.

Two motor:

hypoglossal nucleus and nucleus ambiguus.

9 10 11 MCQ

Two vestibular nuclei:

medial and inferior vestibular nuclei.

Two parasympathetic nuclei:

inferior salivatory nucleus and dorsal motor nucleus of vagus..

Two sensory nuclei

1. Spinal Nucleus of Trigeminal:

Site:

located in **medulla** ascends to the pons and descends to C3 of the **spinal cord**.

Input:

MCQ

It mediates the **pain, temperature and light touch sensations from the same side of the face, oral cavity and external ear** via (**5th, 7th, 9th and 10th** cranial nerves).

Output:

Axons cross to the opposite side and form **trigeminal lemniscus** which end in the **VPMN** of **thalamus**.

2. Nucleus solitaries

Input:

Divided into

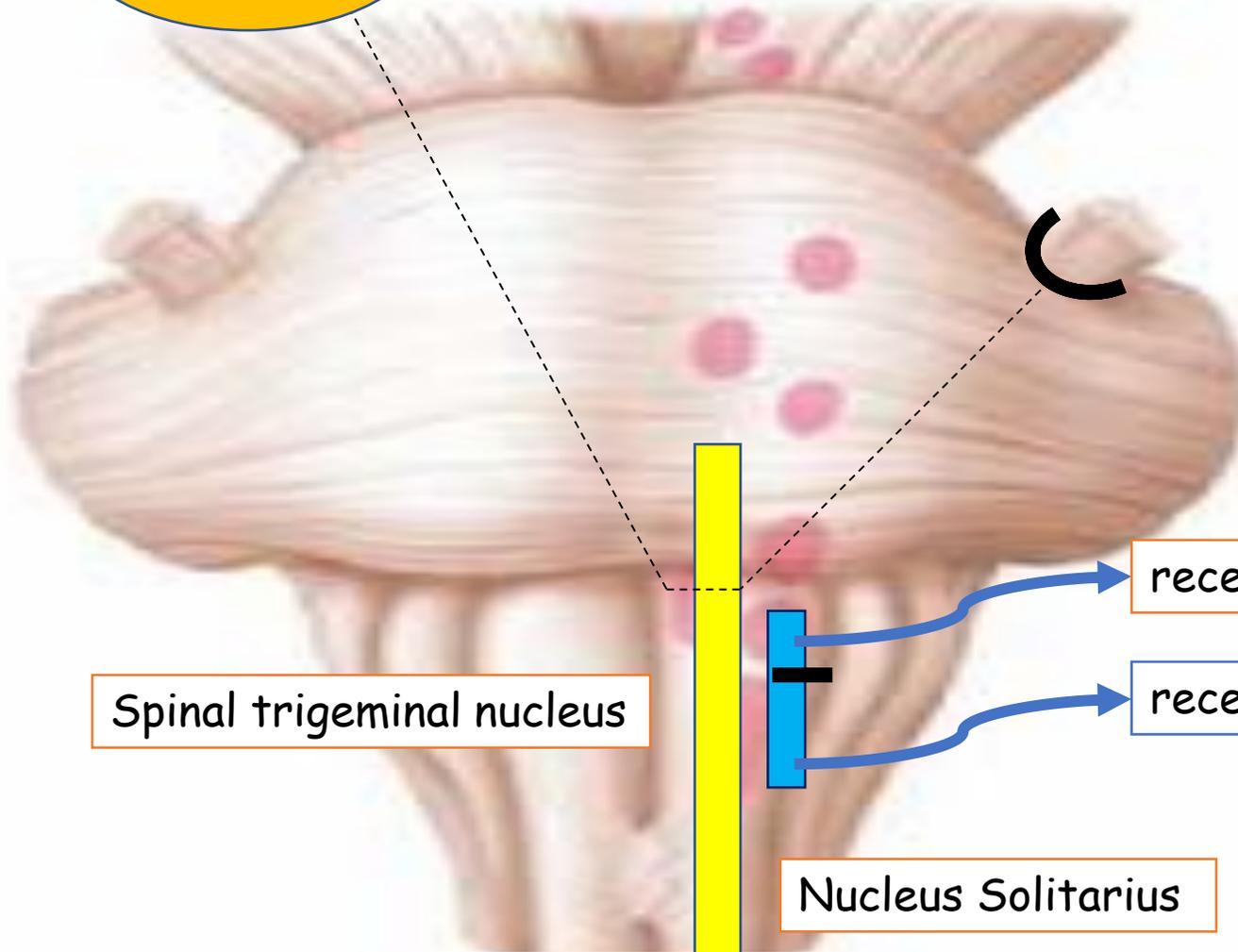
Upper third: receives **taste** sensation from the tongue via (7th, 9th and 10th cranial nerves). **MCQ**

Lower 2 thirds: receive **general** sensation from viscera supplied by (9th and 10th cranial nerves).

Output:

Axons cross the opposite side and terminate in the **thalamus**

Thalamus



Spinal trigeminal nucleus

receives taste sensation from the tongue

receive general sensation from viscera

Nucleus Solitarius

Two motor nuclei:

Hypoglossal Nucleus:

Site: in the floor of the 4th ventricle.

Function: supply **all muscles of the tongue EXCEPT palatoglossus muscle.**

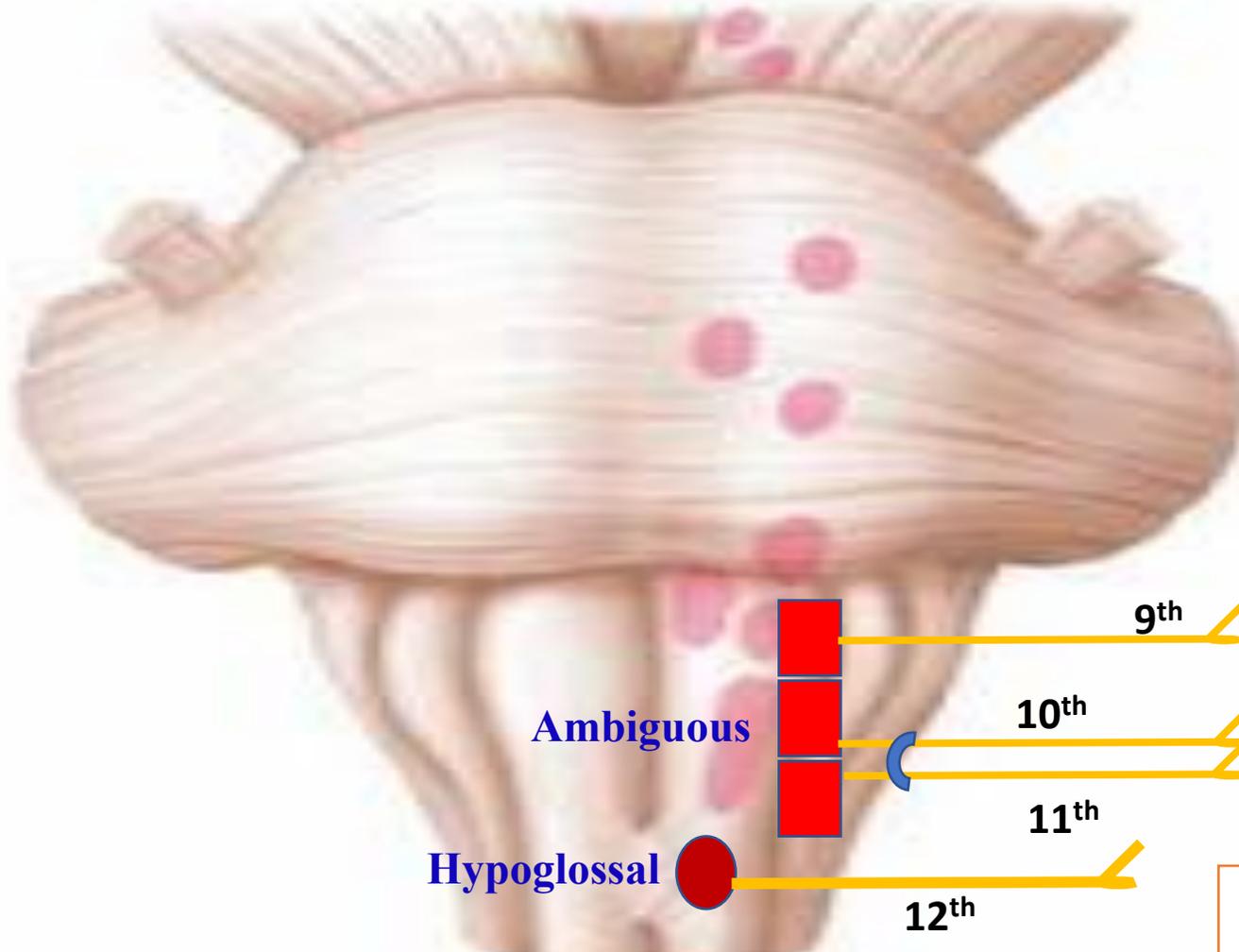
Nucleus Ambiguus:

Divided into 3 parts

Upper part: for the 9th cranial nerve.
middle part: for the 10th cranial nerve.
lower part: for the to 11th cranial nerve

Function:
Supply **all muscles of pharynx, larynx, palate EXCEPT tensor palate muscle**

MCQ



9th Supply stylopharyngeus muscle

10th Supply all muscles of pharynx, larynx, palate except tensor palate

11th supply all muscles of the tongue except palatoglossus muscle.

Two parasympathetic nuclei

Dorsal Motor Nucleus of Vagus.

Site: floor of the 4th ventricle.

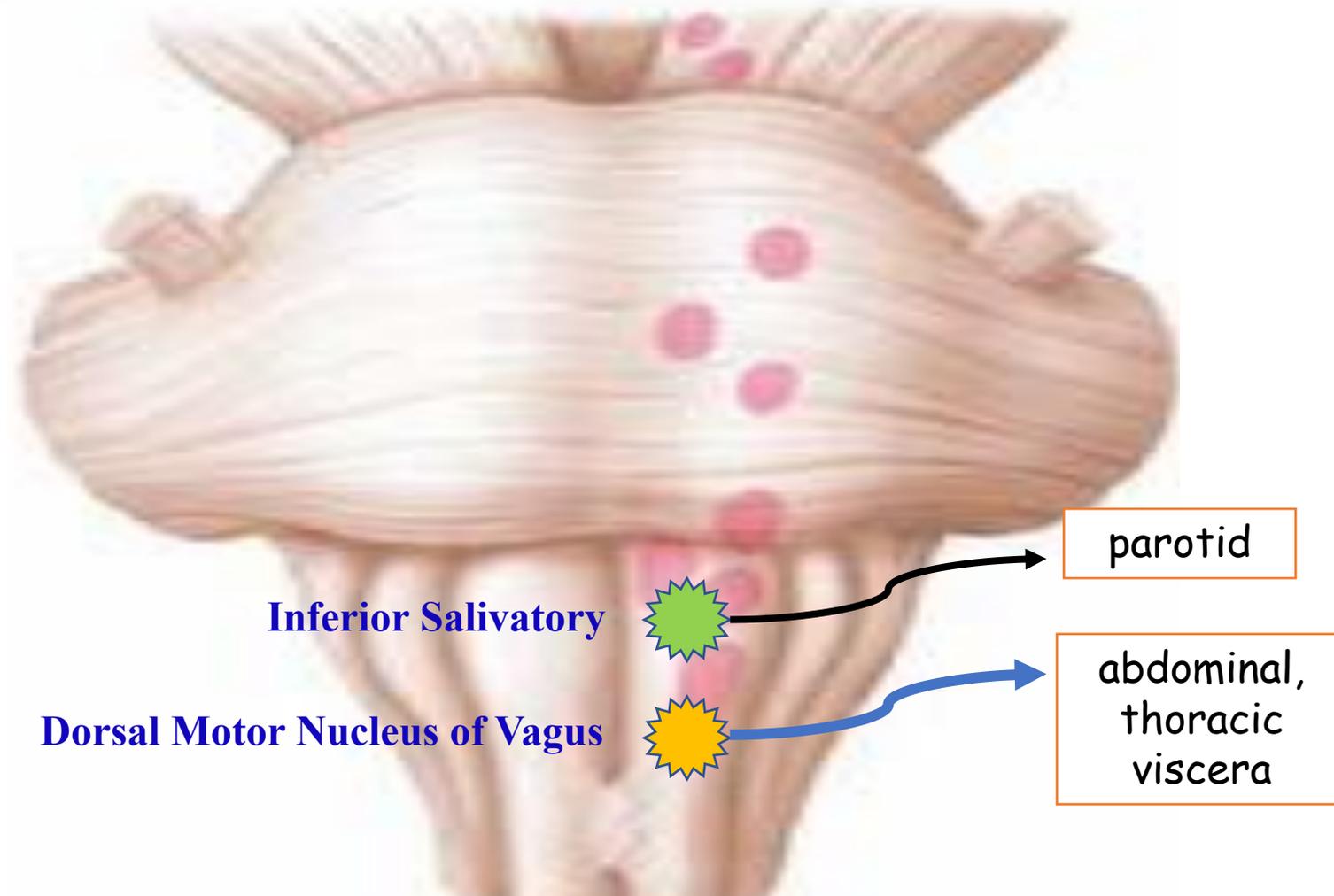
Function:

Supplies the glands, smooth muscles and blood vessels of the **thoracic** and **abdominal** viscera via **10th cranial nerve (Vagus)**

Inferior Salivatory Nucleus:

Function:

Supplies the **parotid** gland through the **9th cranial (glossopharyngeal)**

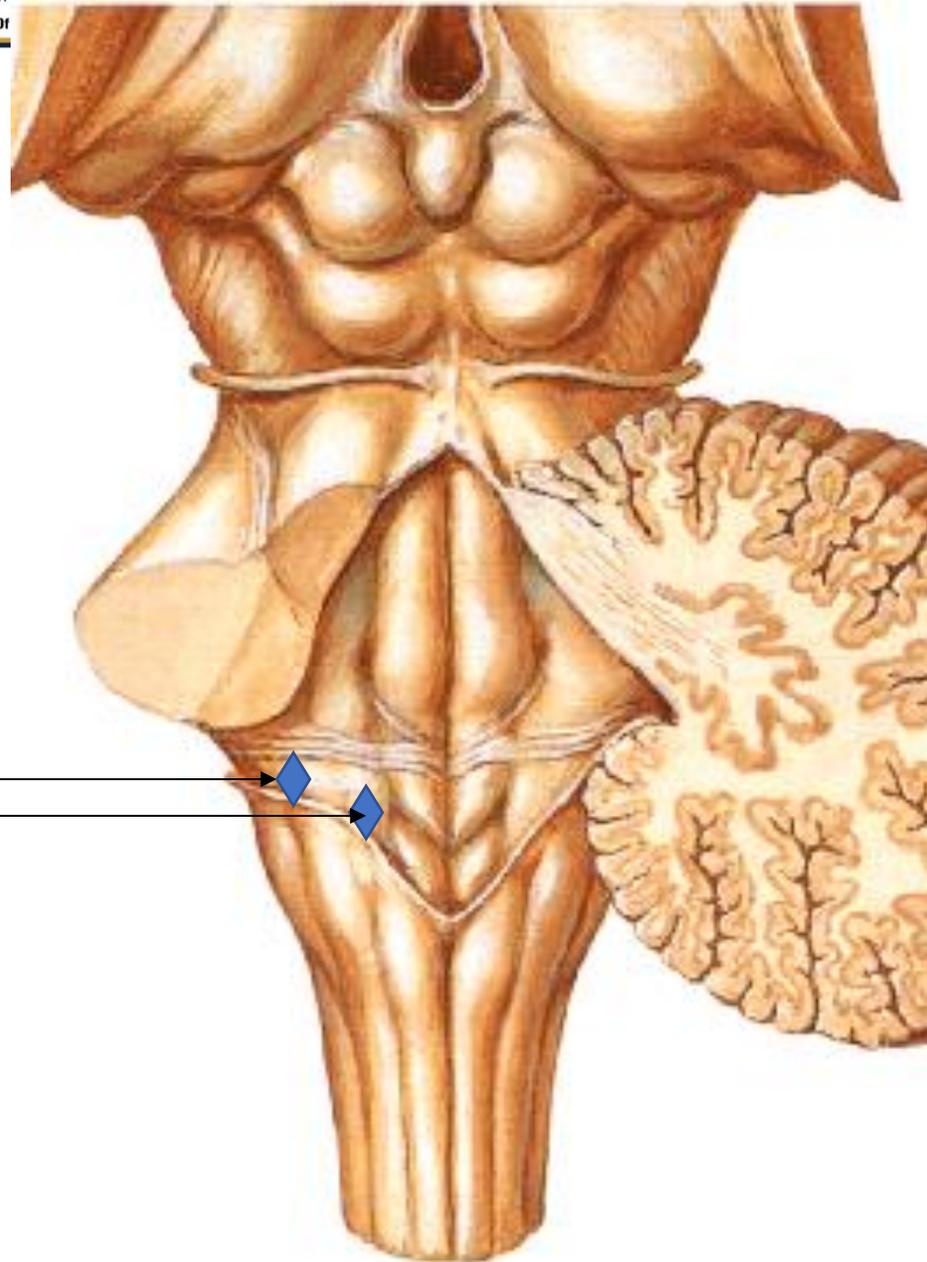


Two vestibular nuclei

Medial and Inferior vestibular nuclei

Site: In the floor of the **4th ventricle**

Function: Maintain balance and **equilibrium**



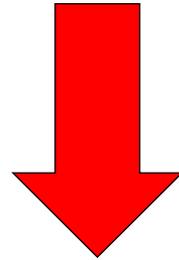
**Inferior and Medial
Vestibular nuclei**



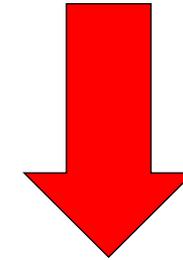


Internal Features of Pons

INTERNAL STRUCTURES OF THE PONS



BASIS PONTIS
Anterior part



TEGMENTUM
Posterior part

BASIS PONTIS

Is the **Anterior** part of the Pons, it contains:

Bundles of the pyramidal tract fibers: Corticospinal fibers and Corticobulbar fibers

Pontine nuclei: 2nd order neurons of the cortico-ponto-cerebellar Pathway.

Transverse pontine fibers: axons of pontine nuclei

Fibers of the middle four cranial nerves: on their way outside the pons

TEGMENTUM

Is the posterior part of the Pons, it contains **4 lemnisci** and **4 cranial nerve nuclei**

TRACTS

1-Four lemnisci: medial lemniscus, trigeminal lemniscus, spinal lemniscus and lateral lemniscus.

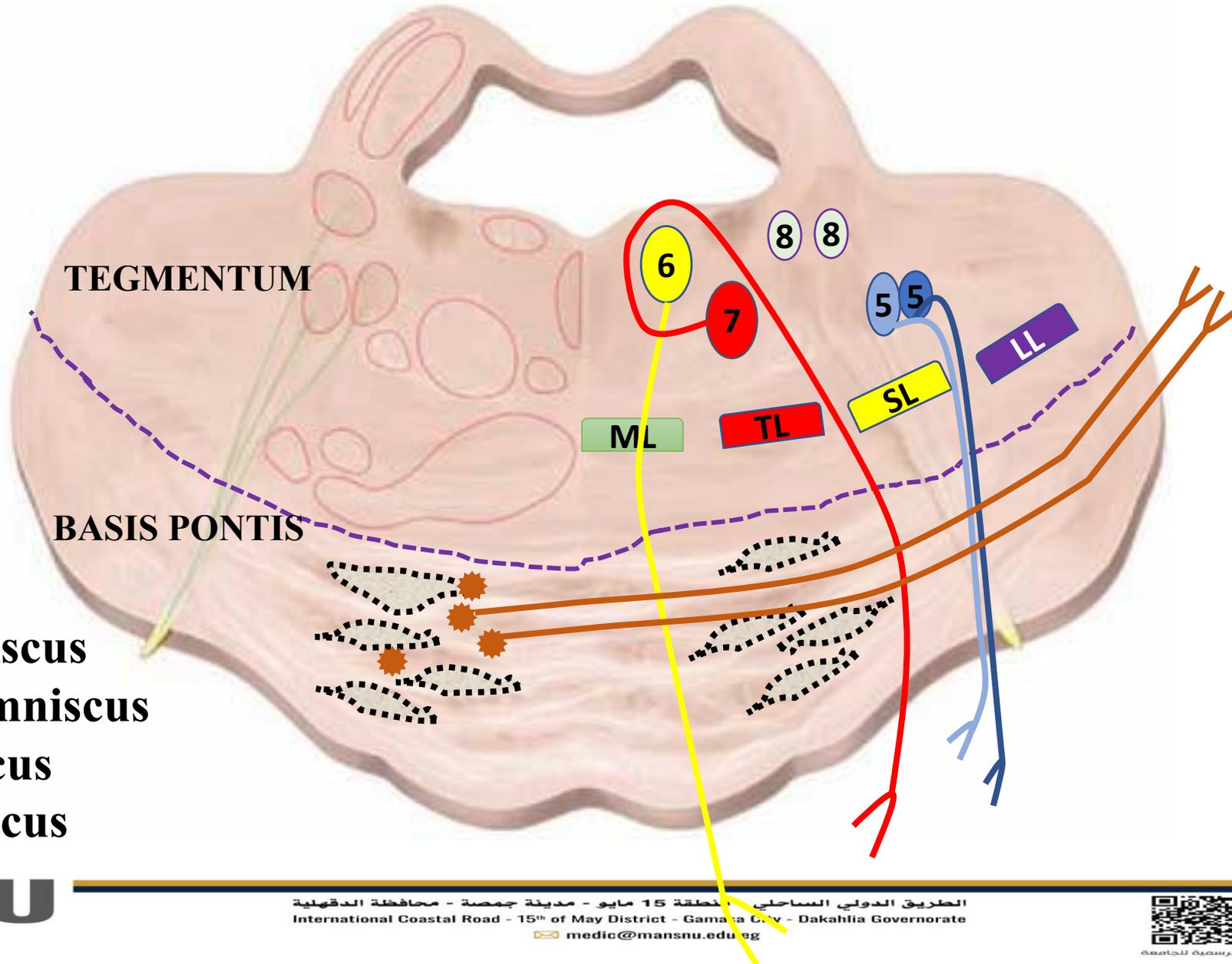
2-Medial longitudinal fasciculus (MLF): it connects the **vestibular nuclei** with motor nuclei that move the eyes (**3rd, 4th and 6th cranial nerves**). To **coordinate the eye movements**

3-Other tracts: e.g: tectospinal, rubrospinal, central tegmental tract and other tracts

Nuclei

Nuclei of the middle 4 cranial nerves: 5th, 6th, 7th and 8th.

Pontine reticular formation



SAQ

- ML**: medial lemniscus
- TL**: trigeminal lemniscus
- SL**: spinal lemniscus
- LL**: lateral lemniscus



Brain stem

Midbrain

Internal features

Department of human Anatomy and Embryology
Faculty of Medicine
Mansoura National University, Egypt

M N U

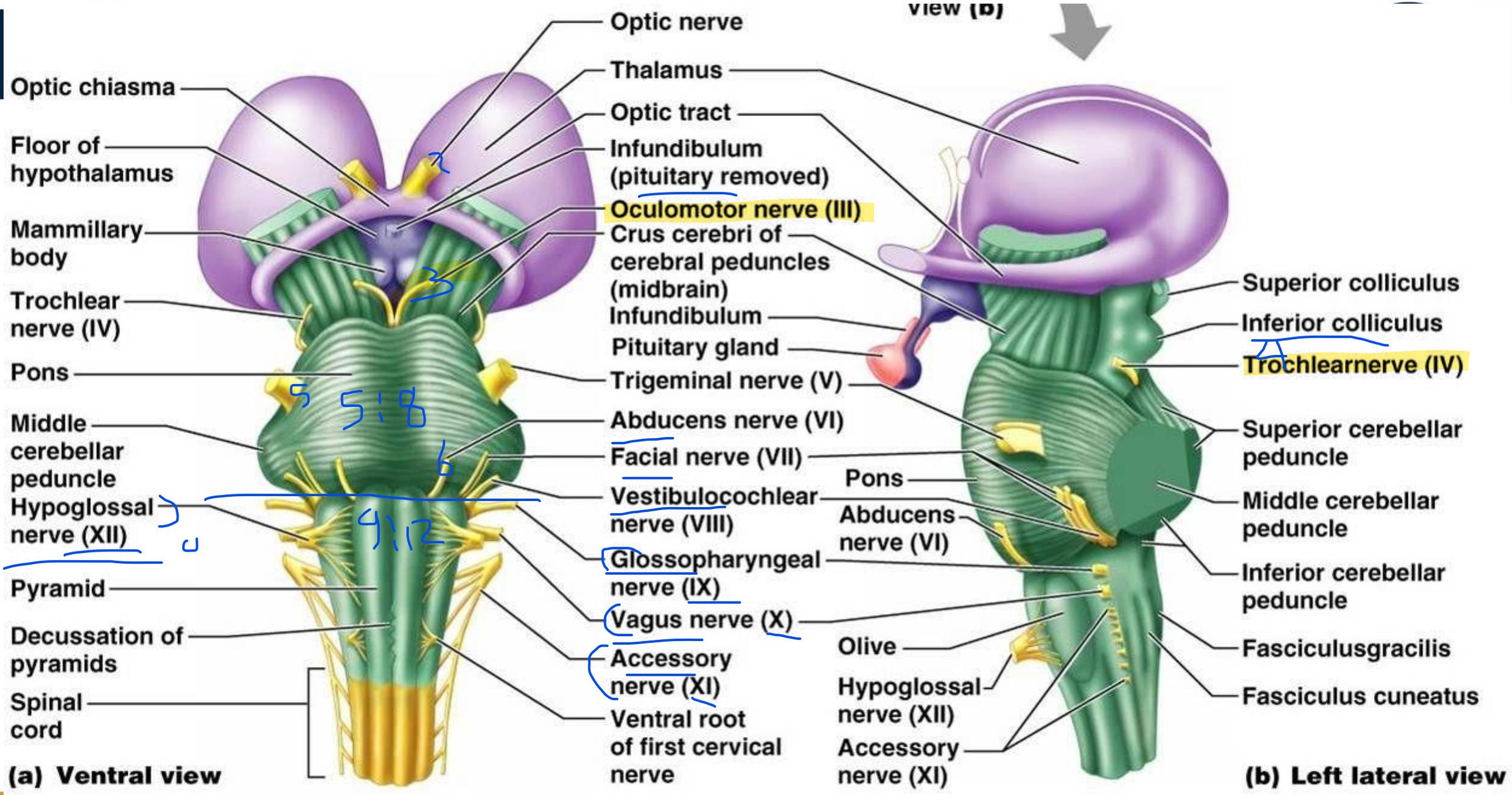


INTERNAL STRUCTURES OF THE MIDBRAIN

The aqueduct divides the midbrain into two parts:

Ventral part:
two cerebral peduncles

Dorsal part:
tectum



CEREBRAL PEDUNCLES

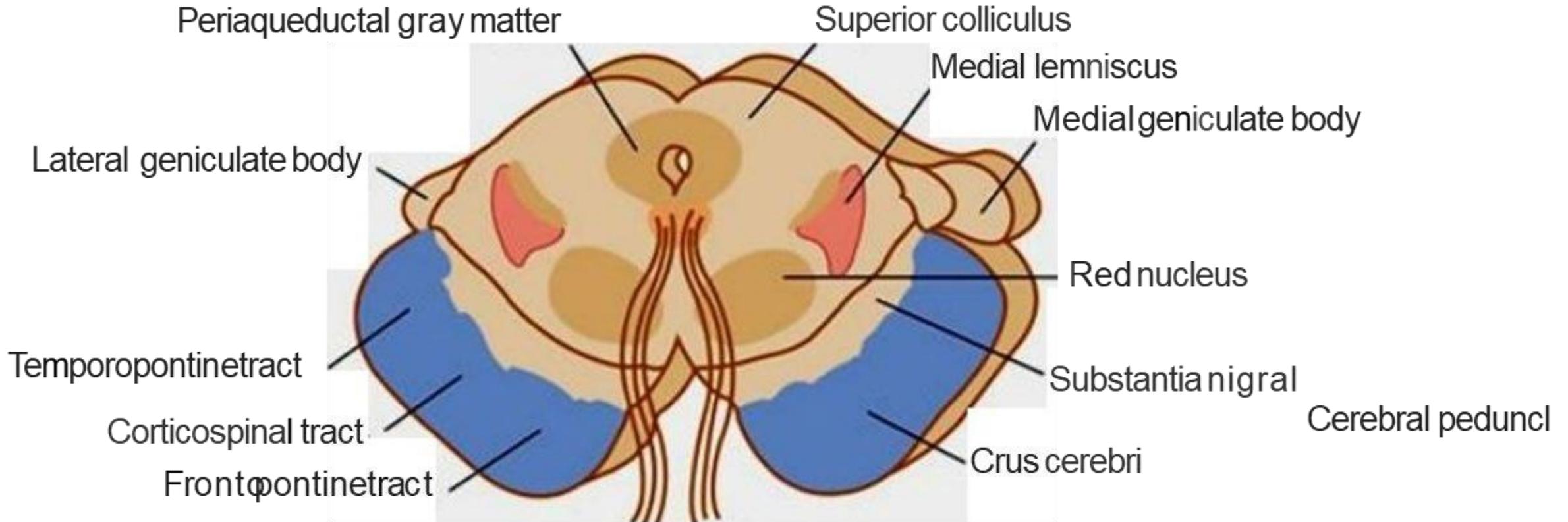
Each cerebral peduncle is divided into 3 parts:

2

1- Crus Cerebri

2- Substantia Nigra

3- Tegmentum

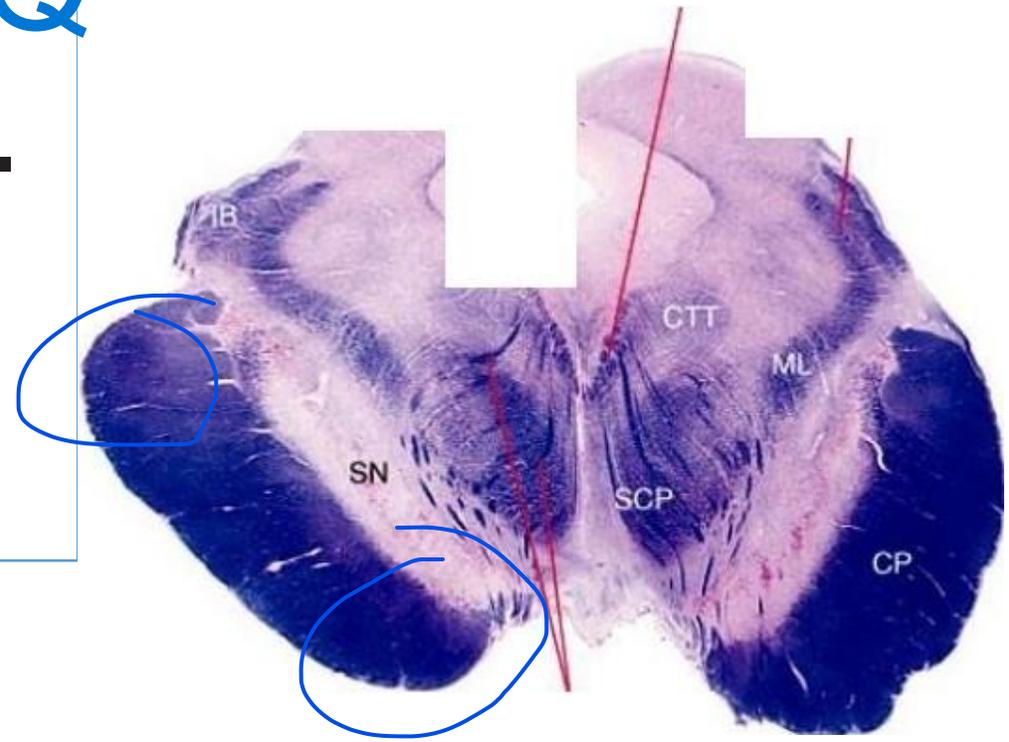


III

1- Crus Cerebri

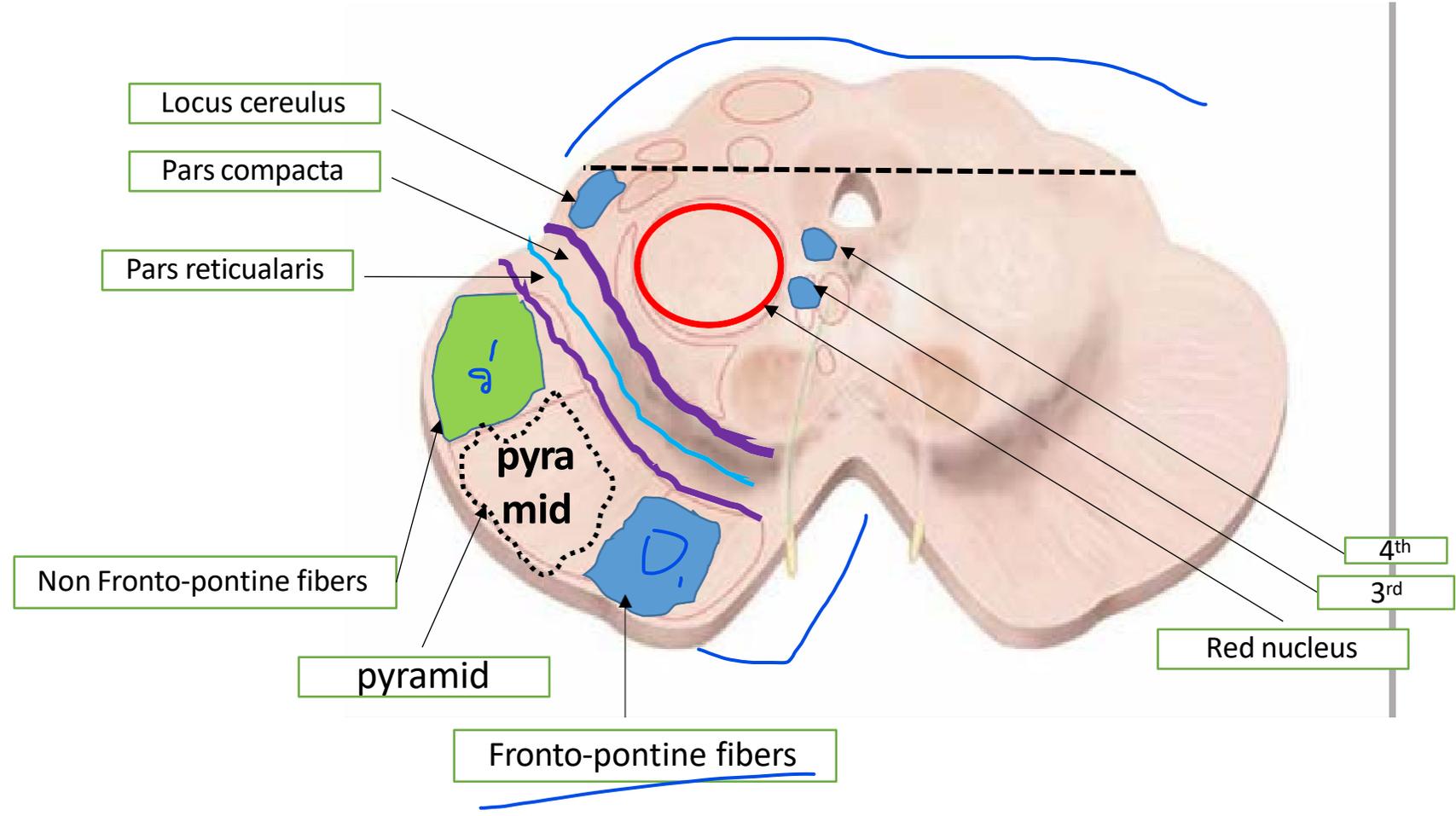
- ❑ It is the anterior part of the cerebral peduncle.
- ❑ It contain the following fibers:
 - 1 medial one fifth: **frontopontine fibers.**
 - 2 lateral one fifth: **nonfrontopontine fibers.**
 - 3 middle 3 fifths: corticospinal and corticobulbar fibers.

MCQ



Handwritten notes in blue ink:

SC	IC
K	H
G	MG



2- Substantia Nigra

It is one of the extrapyramidal motor nuclei.

It is divided into 2 parts:

1 pars compacta:

➤ posterior

➤ The nerve cells contain melanin pigment and secrete **dopamine**.

MCQ

2- pars reticularis:

➤ anterior

➤ The nerve cells secrete GABA.

Lesion: **Parkinson's disease.**

3- Tegmentum

It contains tracts and nuclei

TRACTS

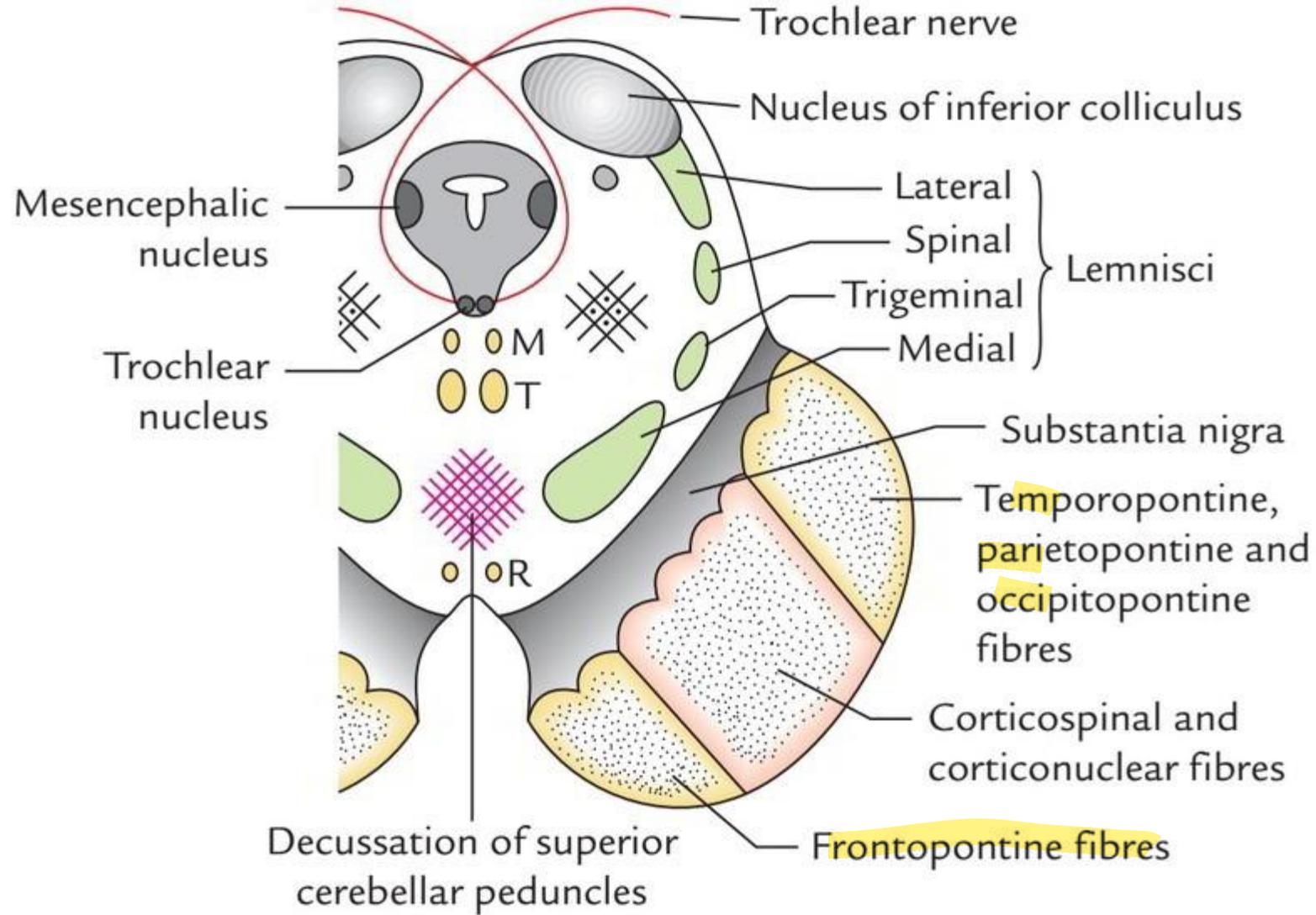
1-Four lemnisci:

medial lemniscus: conveys kinesthesia, discriminative touch and vibration from opposite side of the body.

trigeminal lemniscus: conveys sensation from opposite side of the body.

spinal lemniscus: conveys pain, temperature from opposite side of the body.

lateral lemniscus: conveys auditory sensation to inferior colliculus from the two ears mainly the opposite side.



3- Tegmentum

It contains tracts and nuclei

Nuclei

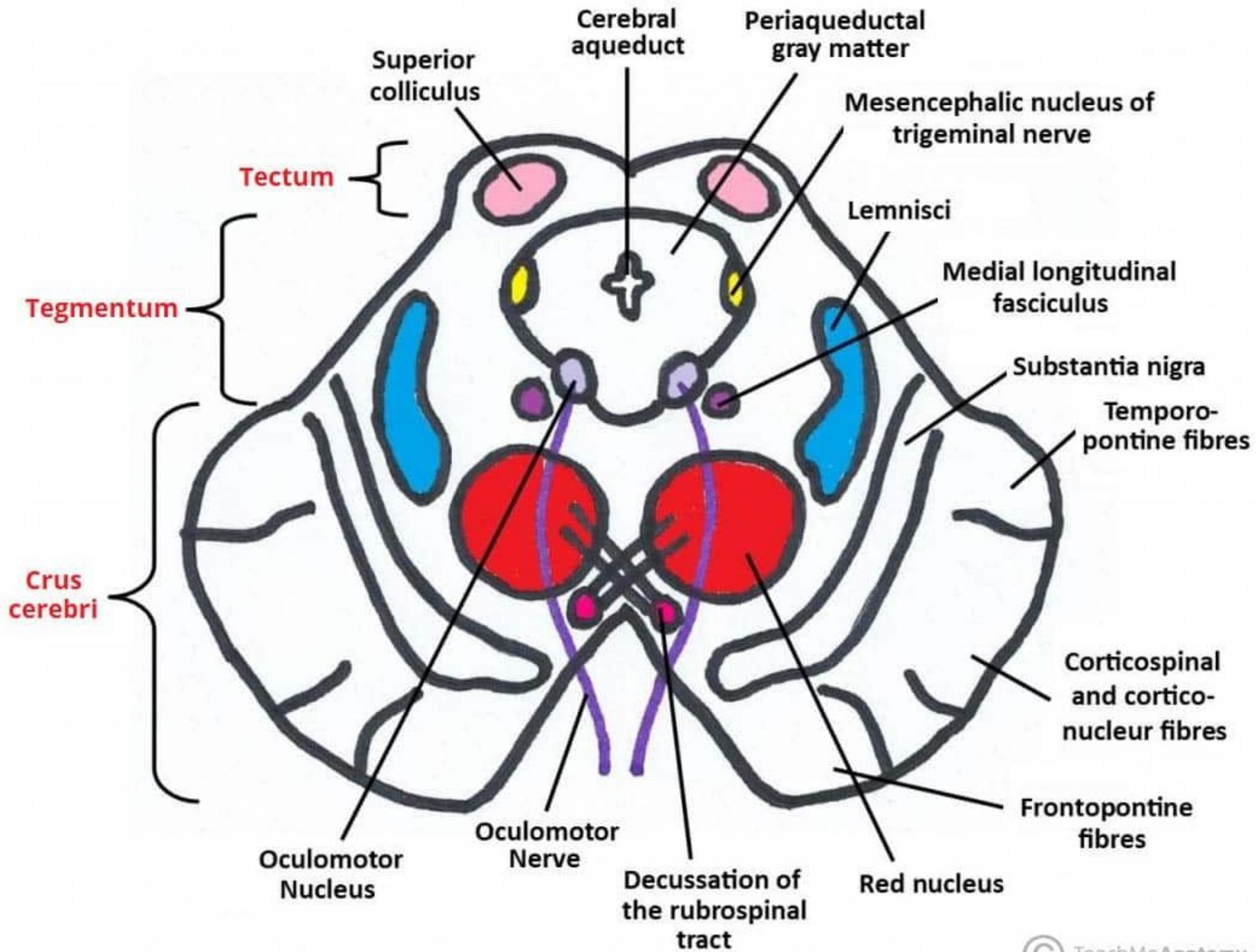
1- Nuclei of the cranial nerves: 3rd (at the level of superior colliculus), 4th (at the level of inferior colliculus), 5th (mesencephalic nucleus) .

2- Other nuclei:

a. **Red nucleus.** Extrapyramidal motor nucleus, at the level of superior colliculus

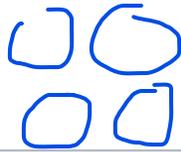
a. **Locus ceruleus:** it is a pigmented area in the upper pons and lower midbrain (at the level of inferior colliculus), cells contain melanin pigments and secrete norepinephrine.

a. **Reticular formation.**



Dorsal part: Tectum

Four colliculi (corpora quadrigemina): 4 rounded elevations
Two superior colliculi
Two inferior colliculi.



	Superior colliculus	Inferior colliculus
Connection to the opposite side	Connected by posterior commissure	Connected by commissure of inferior colliculus
Connection to the thalamus	Connected to <u>lateral geniculate</u> body by superior brachium ^{LG}	Connected to <u>medial geniculate</u> body by inferior brachium ^{MG}
Function	<ul style="list-style-type: none"> ➤ It is not relay nucleus in the visual pathway. ➤ An important visual reflex center. 	<ul style="list-style-type: none"> ➤ A relay nucleus in the auditory pathway.



Blood Supply of The Brain and Spinal Cord

Department of human Anatomy and Embryology
Faculty of Medicine
Mansoura National University, Egypt

M N U

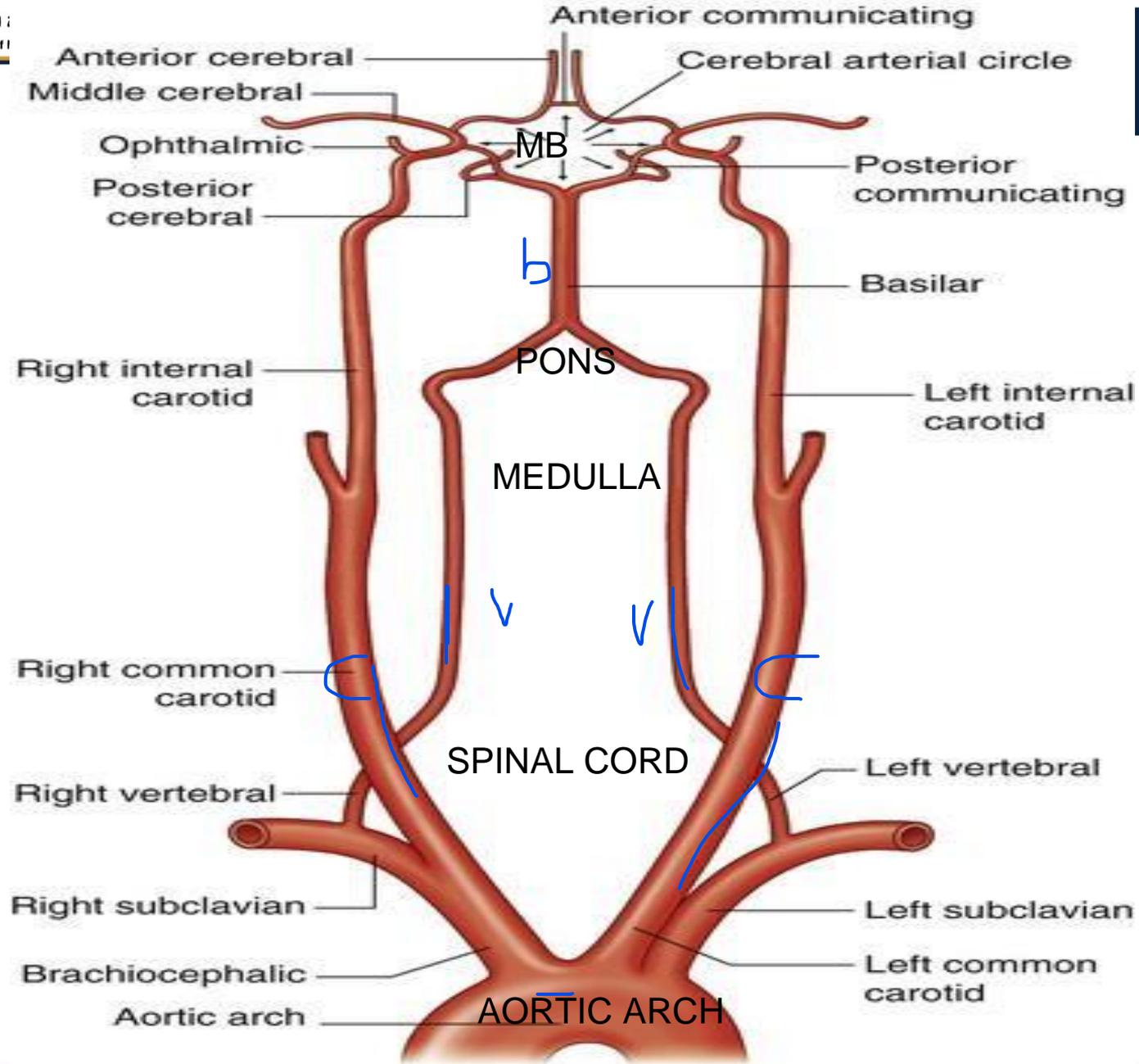


Blood supply of the brain Arterial supply

The brain is supplied by two systems:

- 1. Vertebrobasilar system:** the two vertebral arteries and the basilar artery.
- 2. Internal carotid system:** the two internal carotid arteries.

SAQ



Blood supply of the brain

Arterial supply

Internal Carotid Artery:

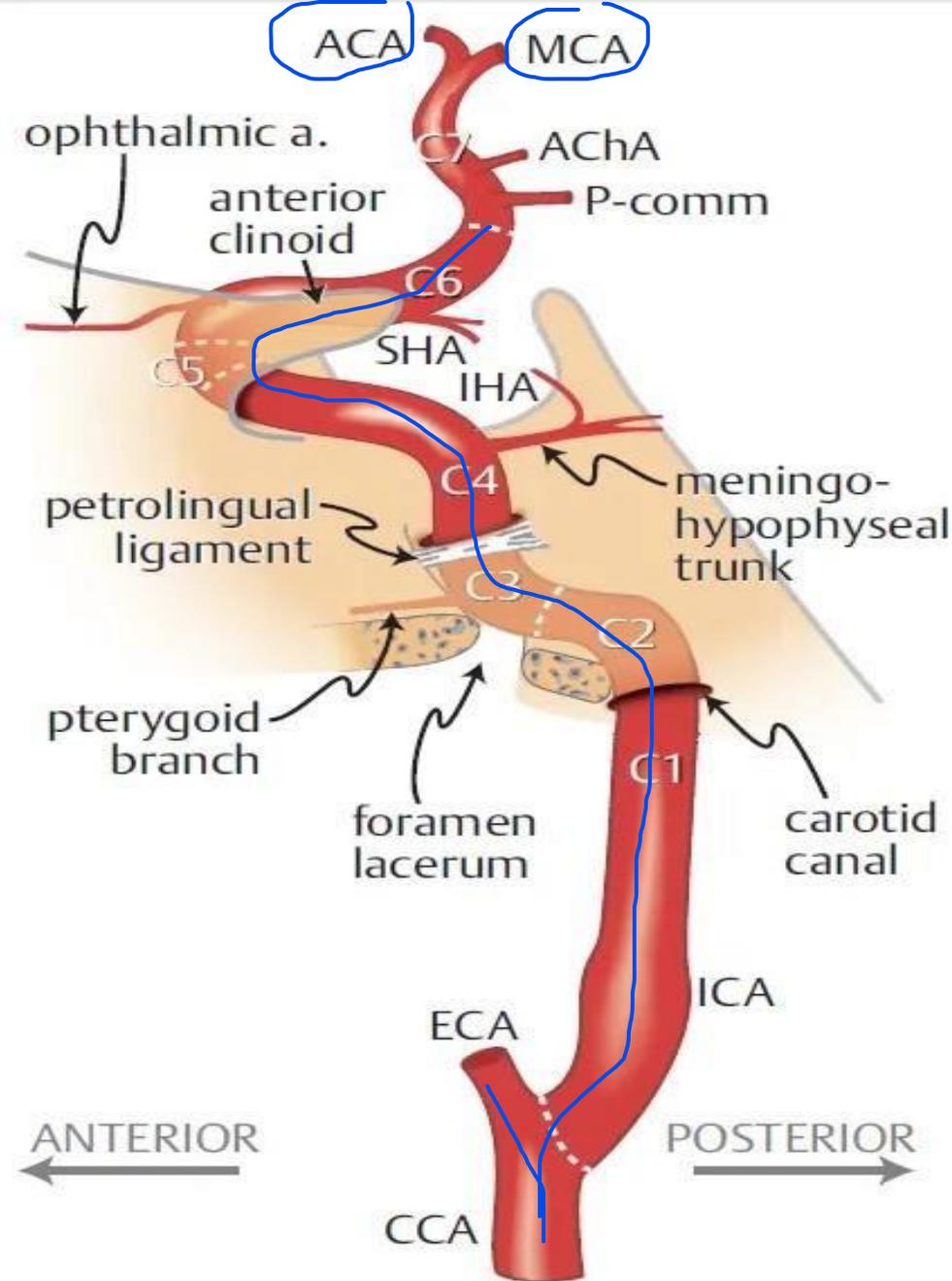
Origin: one of the two terminal branches of the common carotid artery at the upper border of the thyroid cartilage (disc between C3 and C4).

Course: the course of the internal carotid artery is divided into 4 parts:

- 1. Cervical part:** inside the carotid sheath with the internal jugular vein & the vagus nerve.
- 2. Petrous part:** in the carotid canal in the petrous part of the temporal bone.
- 3. Cavernous part:** passes forward inside the cavernous sinus, then pierces its roof to form the supracavernous part.
- 4. Supracavernous part:** passes backward above the cavernous sinus.

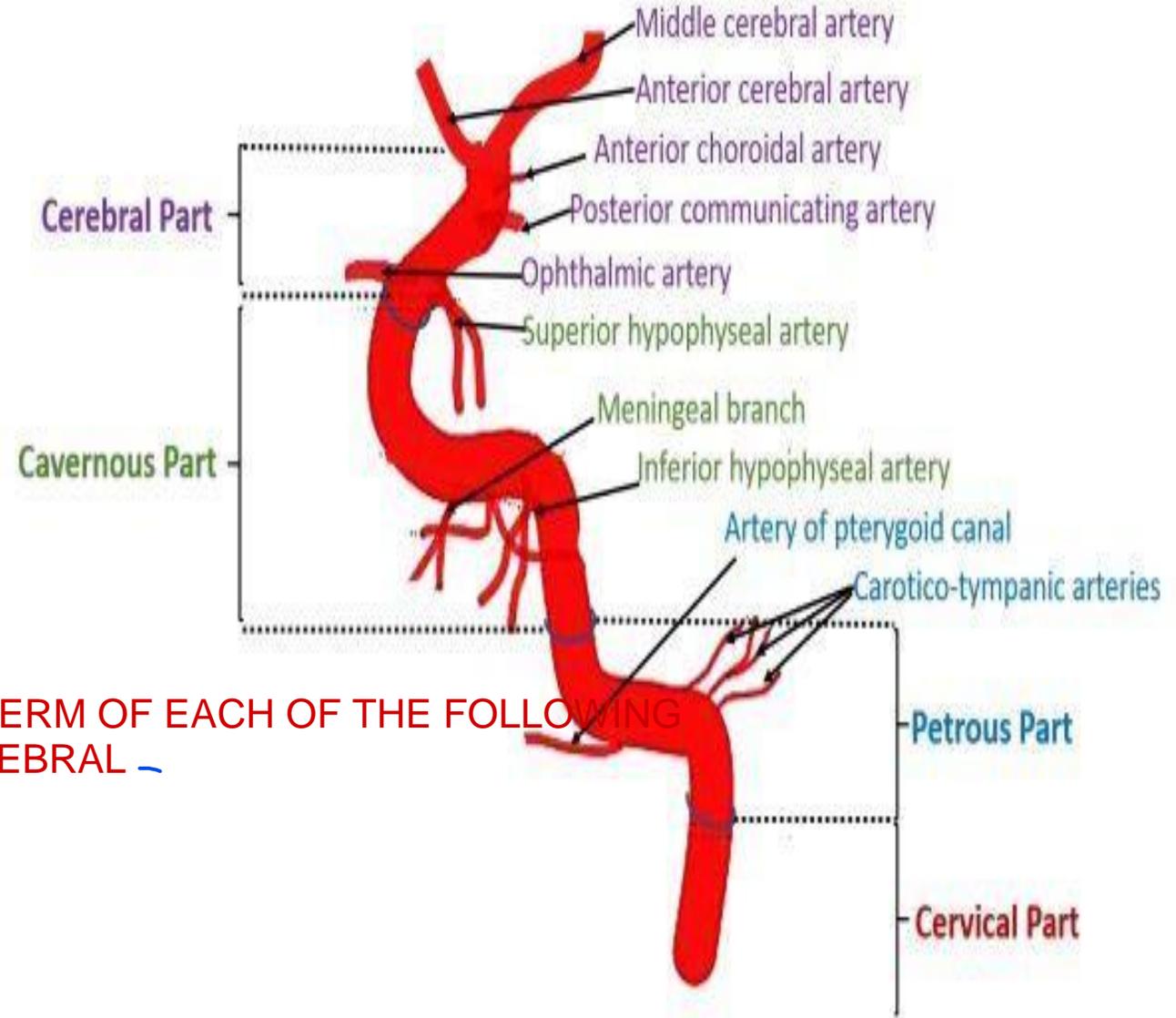
The cavernous and supracavernous parts form the carotid siphon (U-shaped in the angiogram)

Termination: lateral to optic chiasma by dividing into anterior & middle cerebral arteries.



Branches of internal carotid artery:

1. **Hypophyseal branches:** superior and inferior. They supply the pituitary gland.
2. **Ophthalmic artery:** enters the orbit through the optic canal.
3. **Posterior communicating artery:** joins the posterior cerebral artery and supplies the: **Midbrain, thalamus and hypothalamus.**
4. **Internal capsule:** posterior part of the genu & anterior third of the posterior limb.
5. **Anterior choroidal artery** supplies the:
 - 6. **Posterior two-thirds** of the posterior limb of the internal capsule.
 - 7. **Choroid plexus** of the **inferior horn** of the lateral ventricle.
 - 8. Optic tract and lateral geniculate body.
 - 9. Tail of the caudate nucleus and amygdaloid nucleus.
5. **Two terminal branches:** anterior cerebral artery and middle cerebral artery.



BEG & TERM OF EACH OF THE FOLLOWING
A. VERTEBRAL
B. ICA:

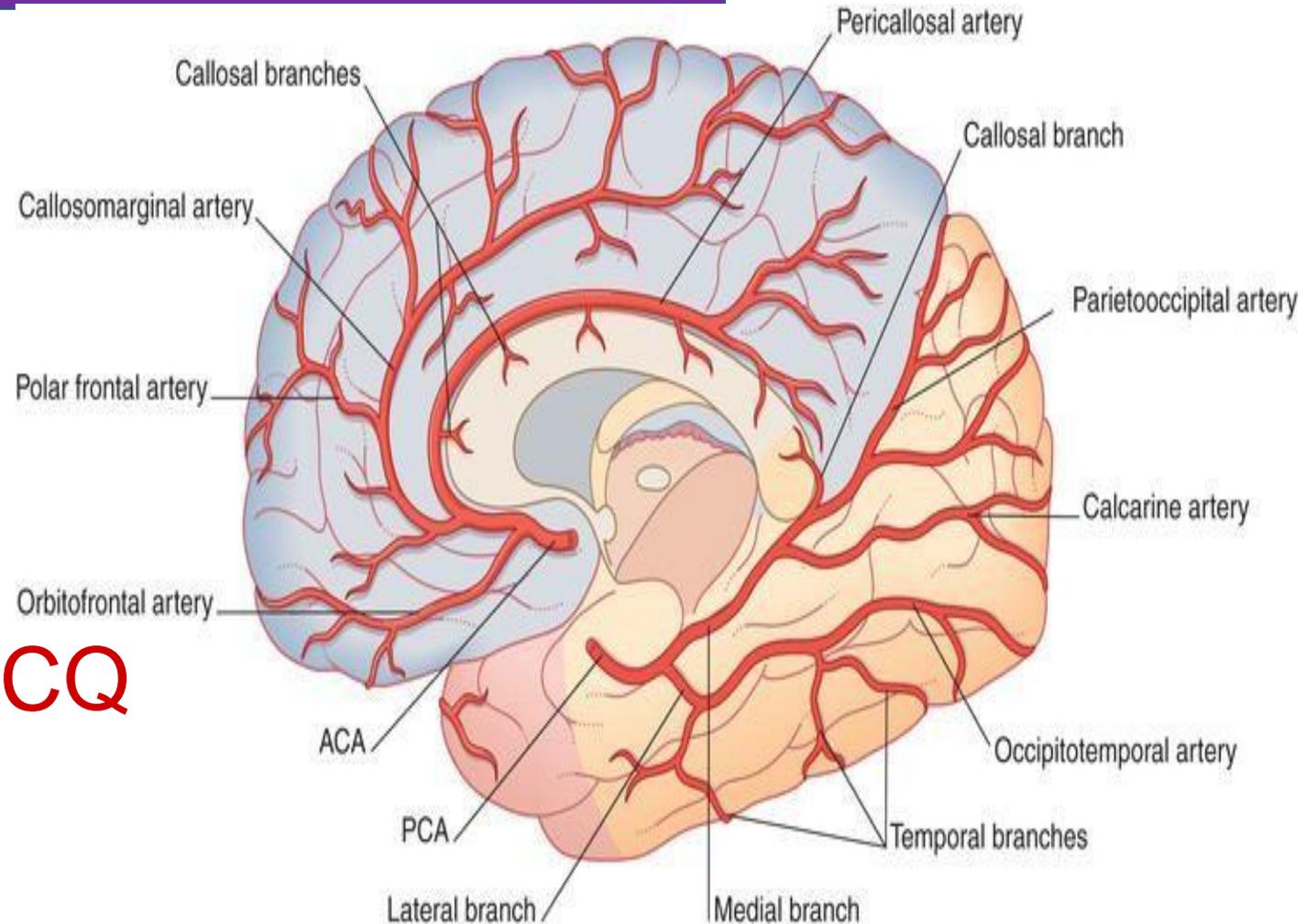
Anterior cerebral artery (ACA)

ORIGIN: one of the two terminal branches of the internal carotid artery (it is the **smaller one**). MCQ

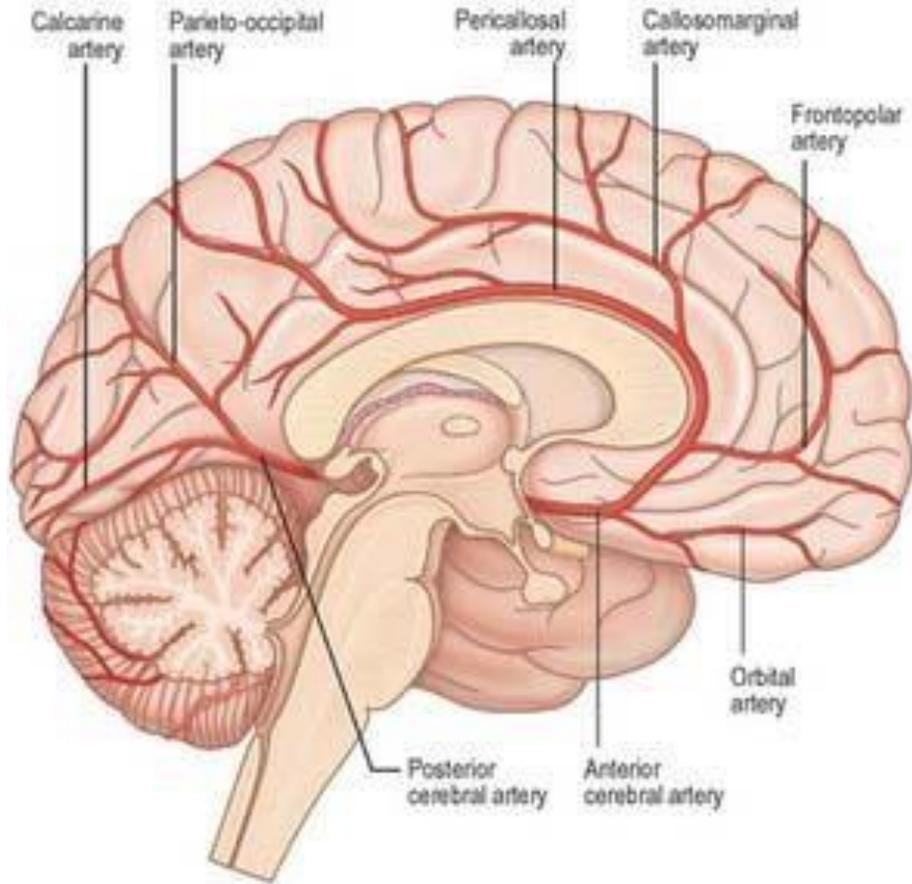
Course: It is joined with the opposite one by the anterior communicating artery.

It passes around the **genu** of the corpus callosum and continues backward on the upper surface of the corpus callosum in the **callosal sulcus**. MCQ

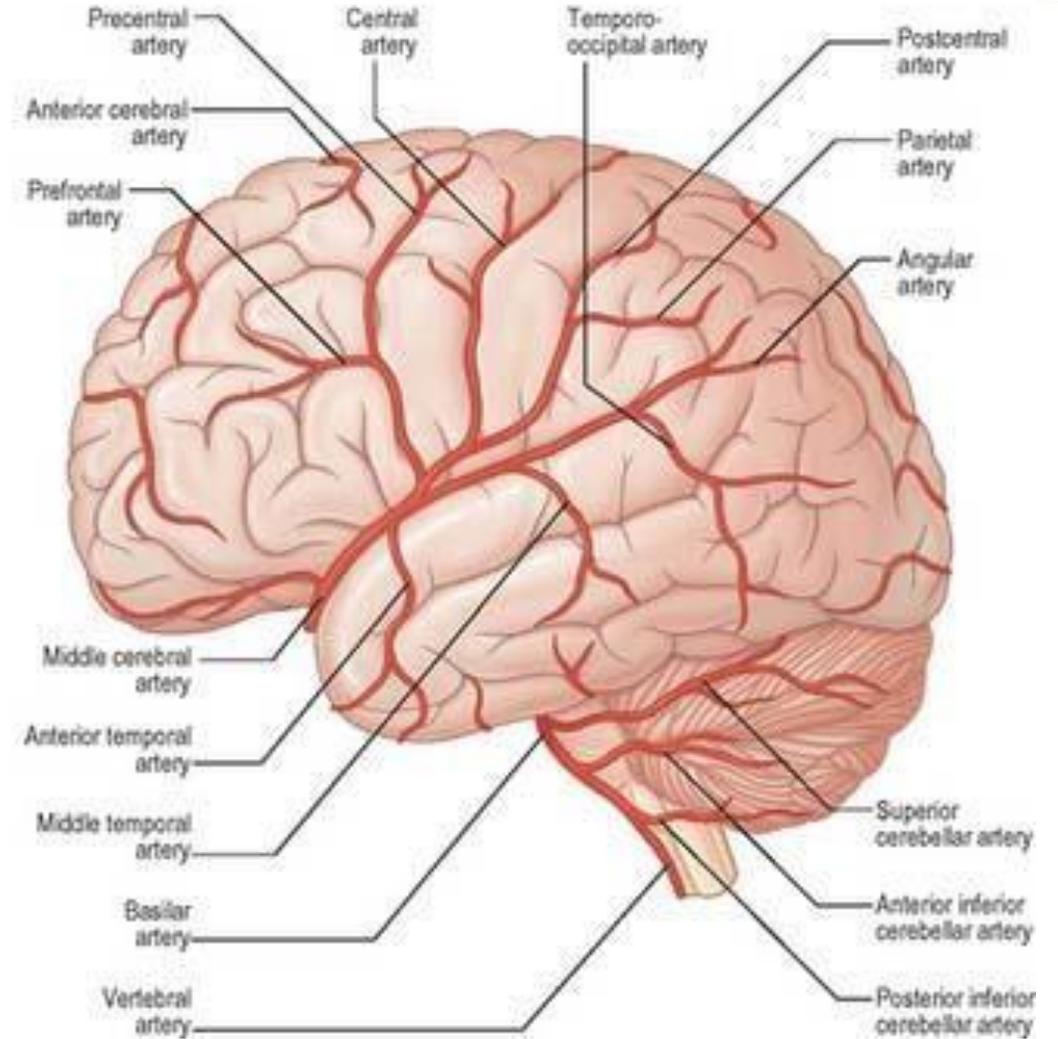
It ends at the **splenium** by anastomosing with branches of the **posterior cerebral artery**.



A



B



Anterior cerebral artery (ACA)

Branches:

1. Cortical branches: supply:

Upper **one inch** of the **lateral surface** of the frontal and parietal lobes. It supplies the **leg area** of the motor and sensory cortical areas.

Medial surface of the frontal and parietal lobes.

Medial half of the orbital surface.

2. Central branches: supply: (4 anterior)

Anterior limb of the internal capsule.

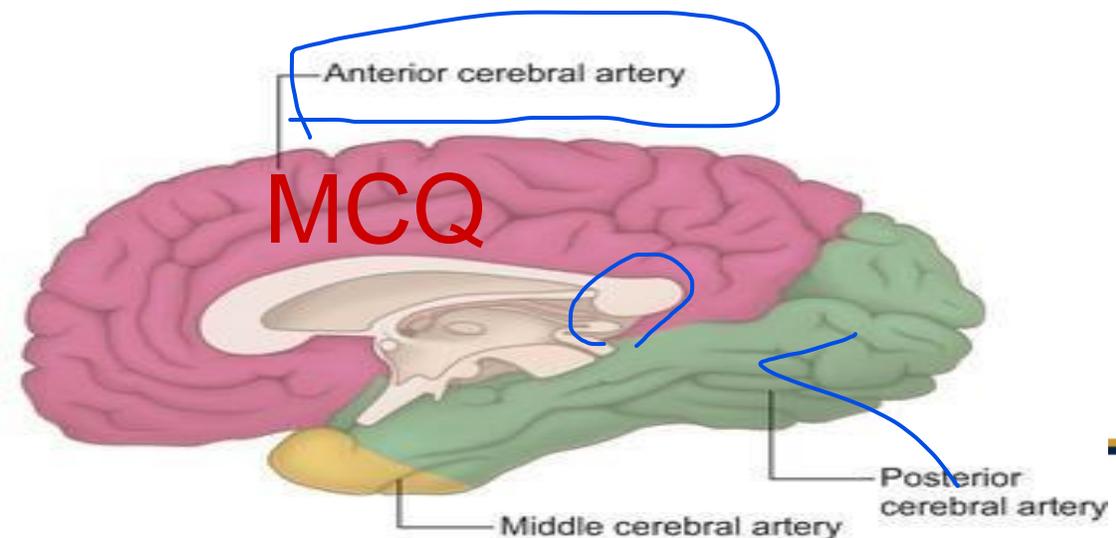
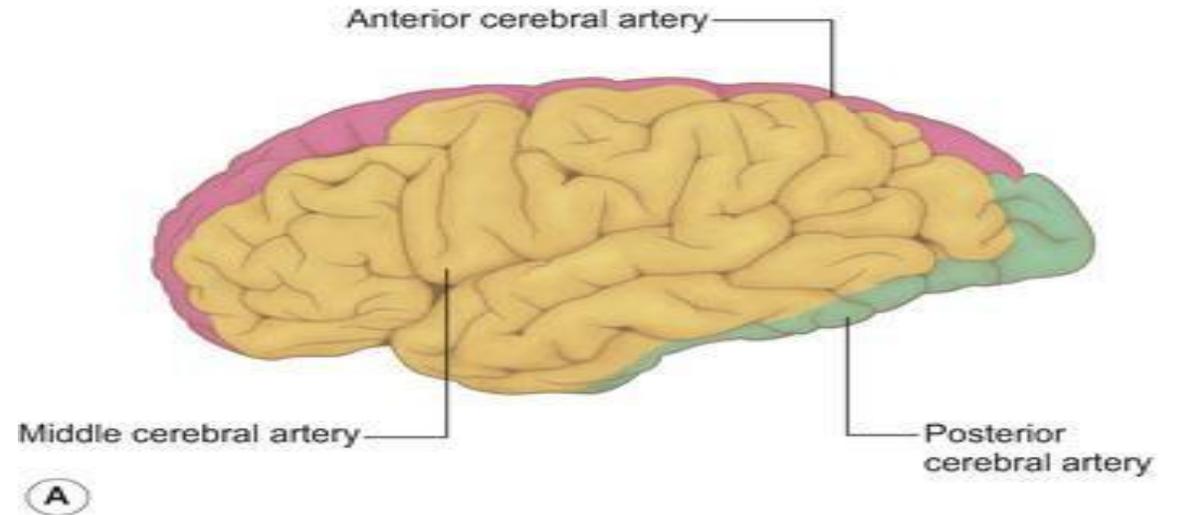
Anterior part of the genu of the internal capsule.

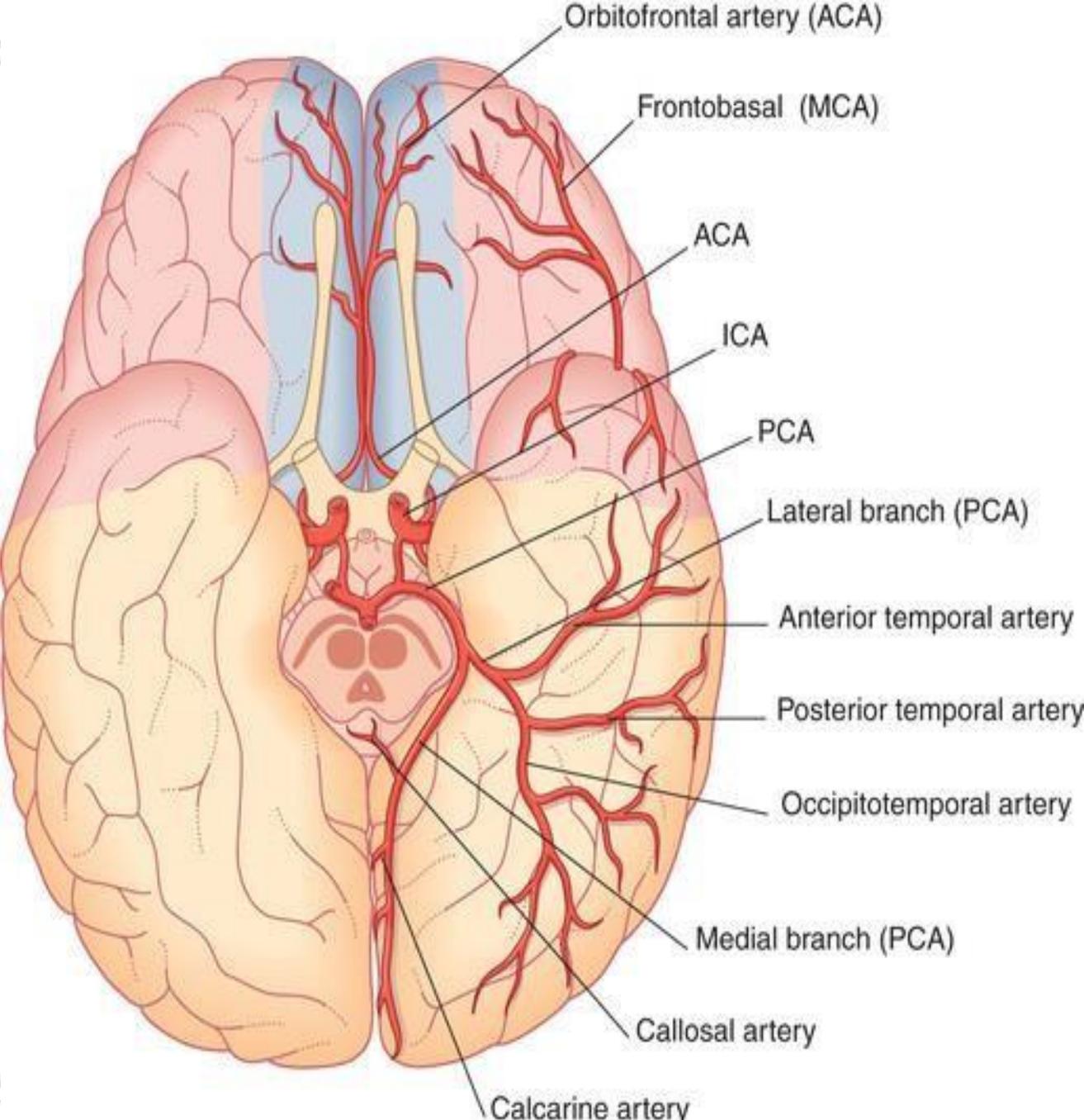
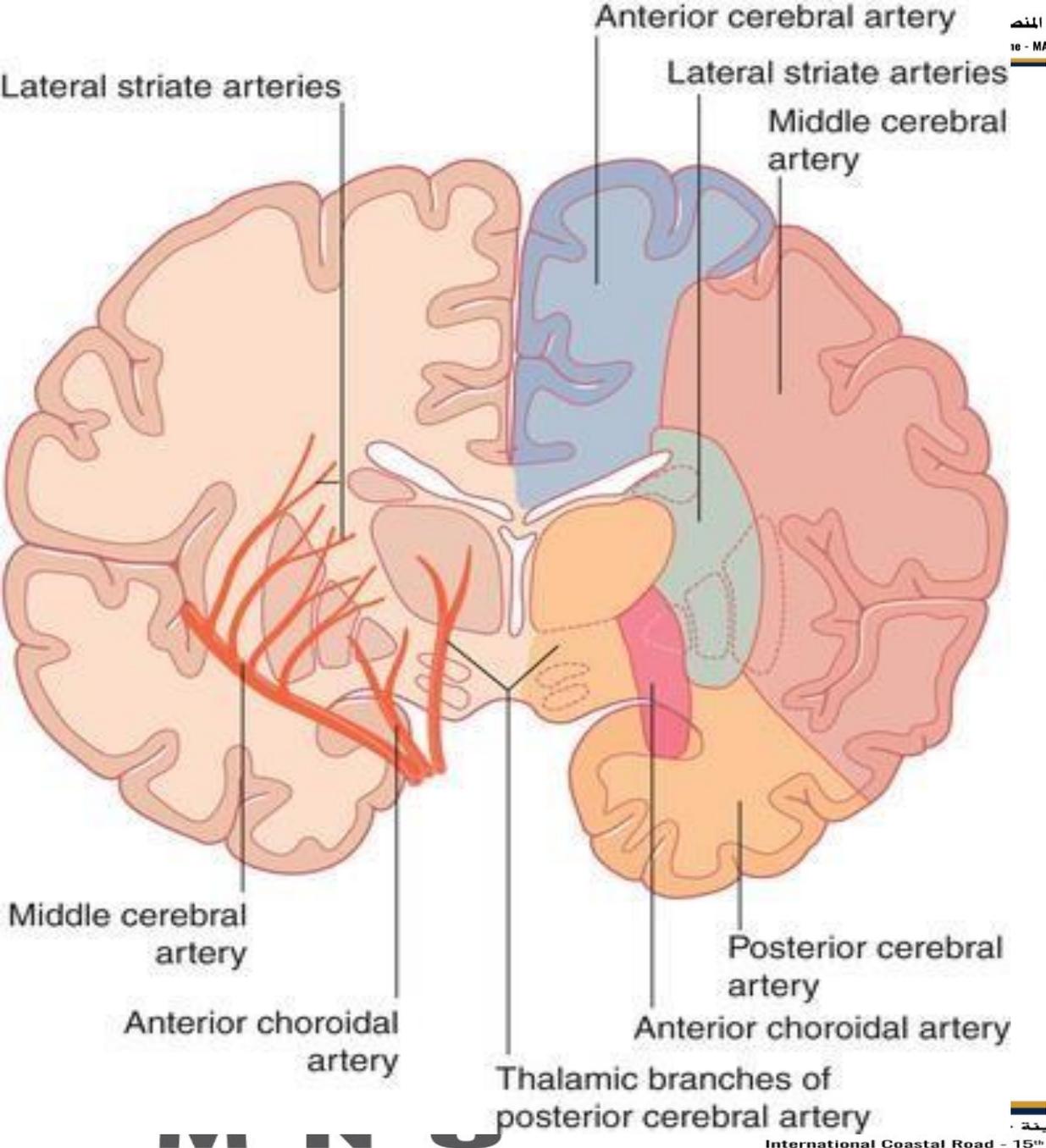
Anterior part of corpus striatum: lentiform nucleus & head of caudate nucleus.

Anterior part of the hypothalamus.

3. Callosal branches: to the entire corpus callosum.

MCQ





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MCQ

Posterior cerebral artery (PCA)

Origin: by the bifurcation of the basilar artery at the upper border of the pons.

Course:

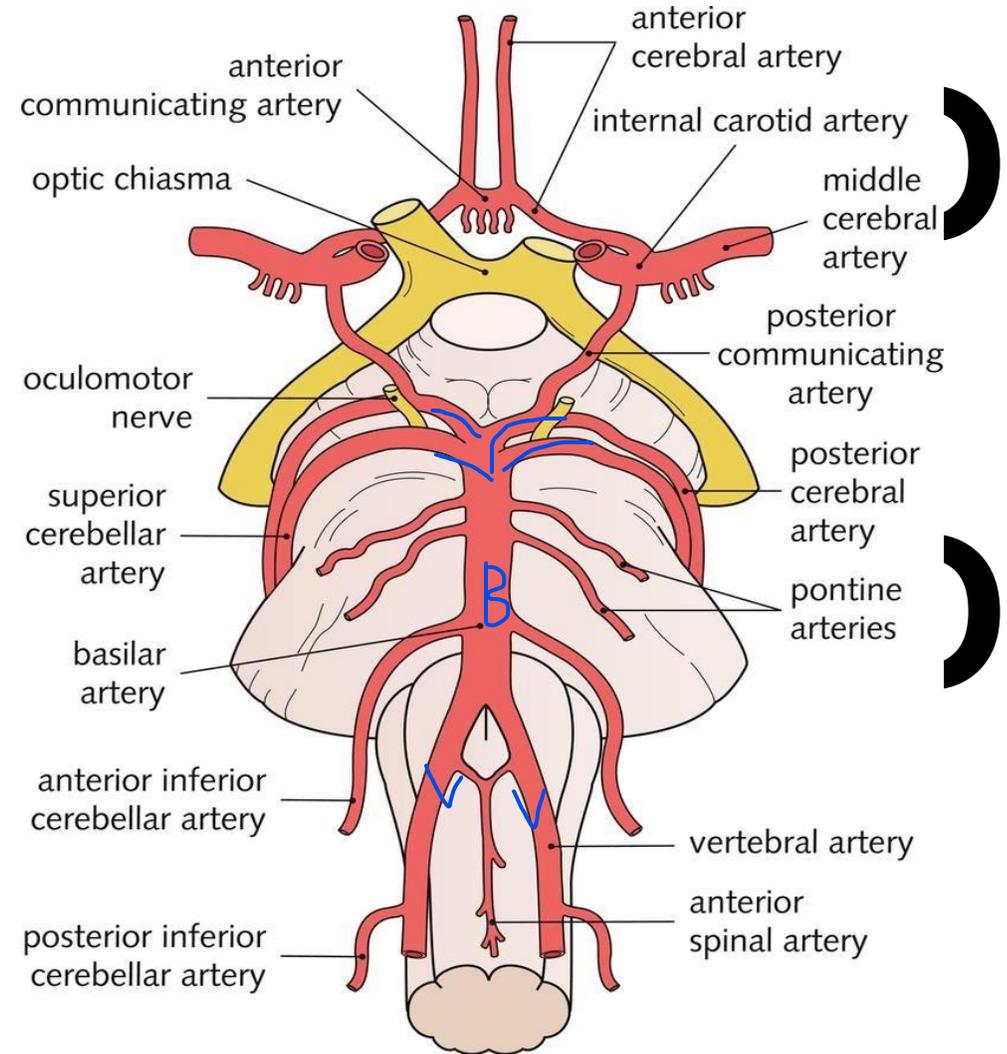
It passes backward around the lateral side of the midbrain to reach the splenium of the corpus callosum where it divides into temporal, calcarine and parieto-occipital branches.

The temporal branches are distributed over the inferior surface of the temporal lobe.

The other branches run in the corresponding sulci and anastomose with branches of the anterior cerebral artery.

It is joined with the internal carotid artery by the posterior communicating artery.

It is separated from the superior cerebellar artery by the oculomotor and trochlear nerves.



Posterior cerebral artery (PCA)

Branches:

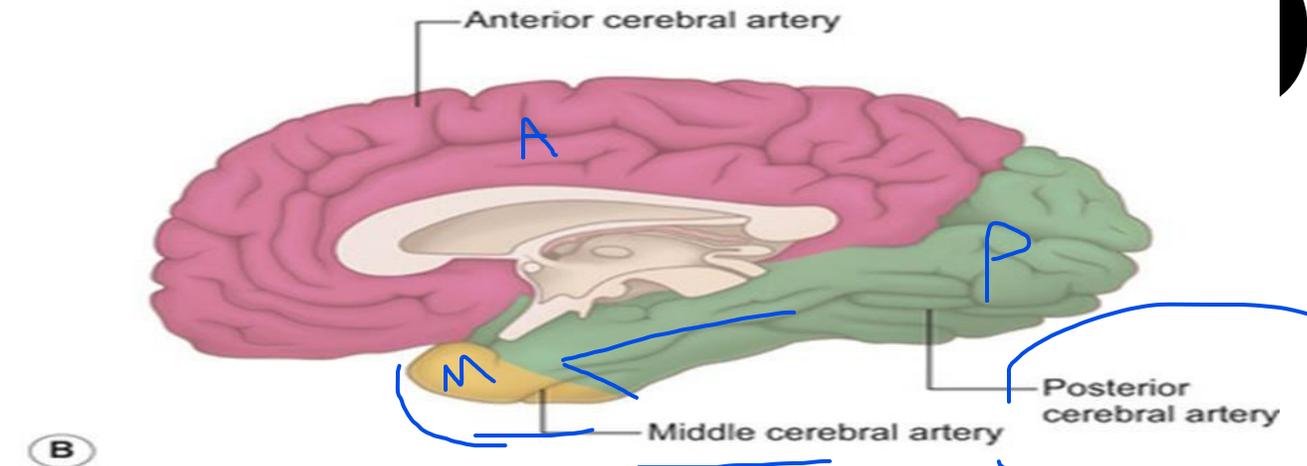
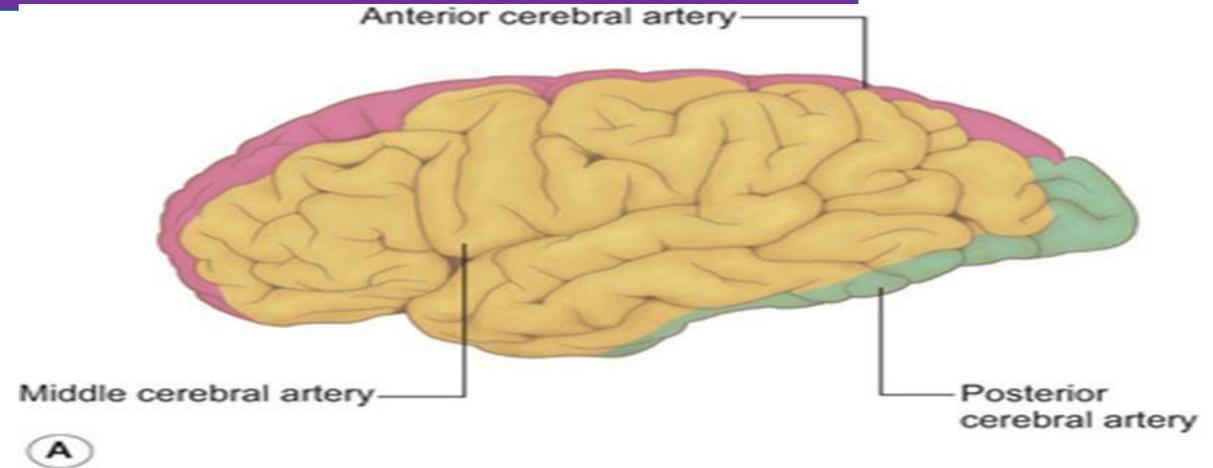
1. Cortical branches: supply:

Lower inch of the lateral surface (inferior temporal gyrus).

All aspects of the occipital lobe. It supplies the primary visual area (area 17) and the visual association areas (areas 18 & 19).

Medial and inferior surfaces of the temporal lobe except the temporal pole.

2. Central branches: enter through the posterior perforated substance and supply: Thalamus and the hypothalamus. Midbrain.



Posterior cerebral artery (PCA)

Posterior choroidal artery: supplies:

- ☐ Choroid plexus of the **third and lateral ventricles.**
- ☐ Thalamus
- ☐ Midbrain.

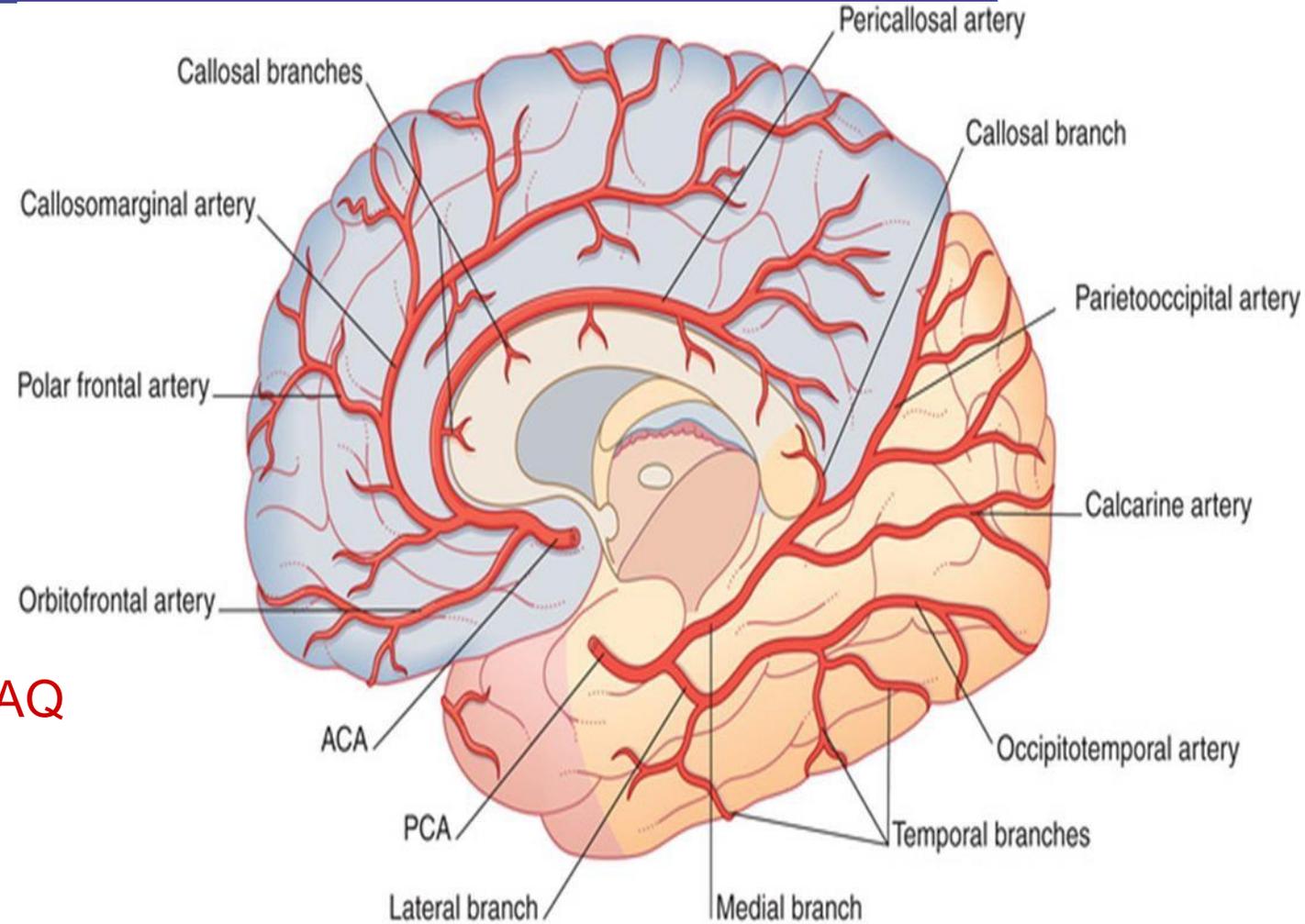
4. Splenial artery: it may be present and supplies the splenium of the corpus callosum.

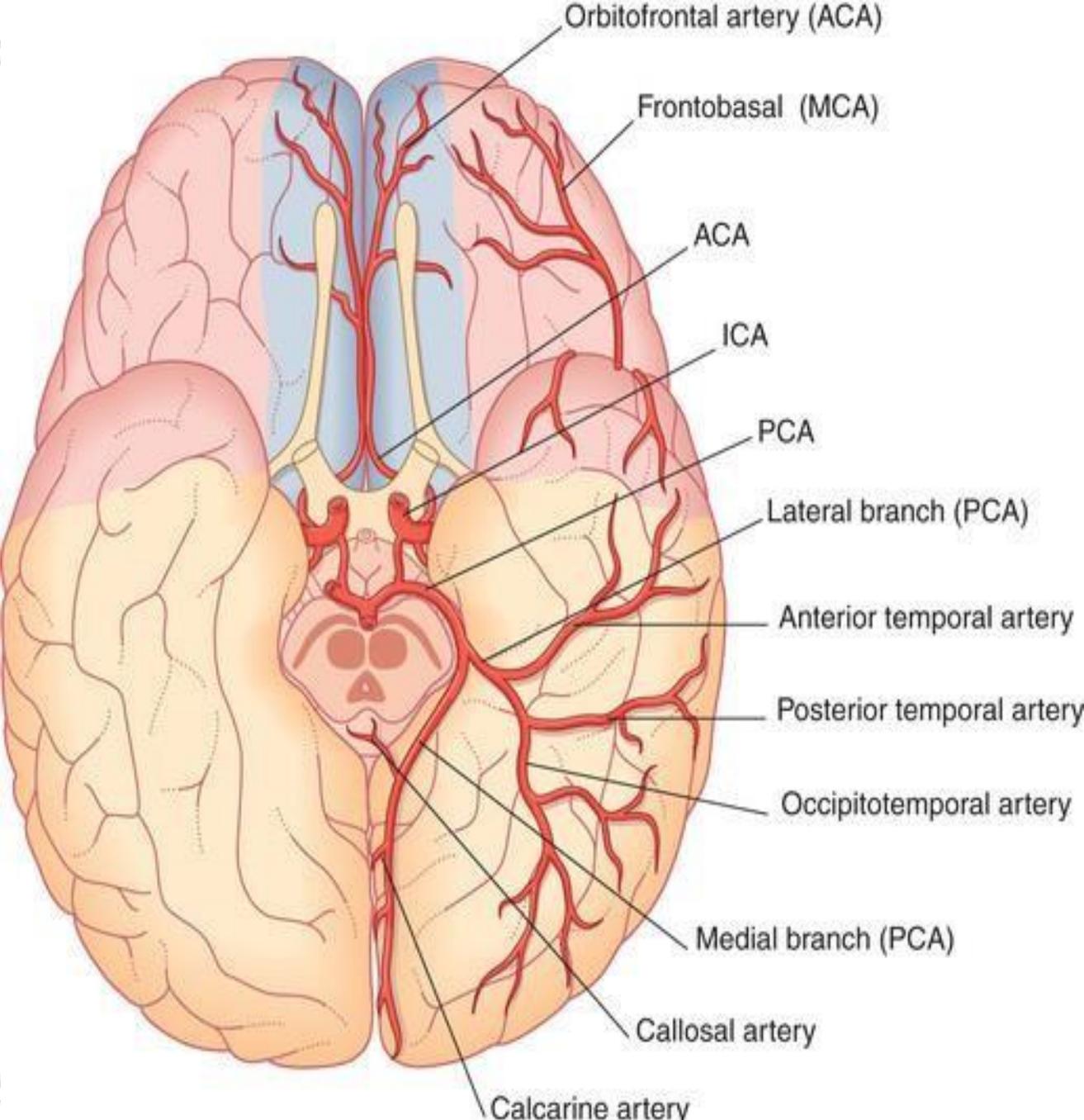
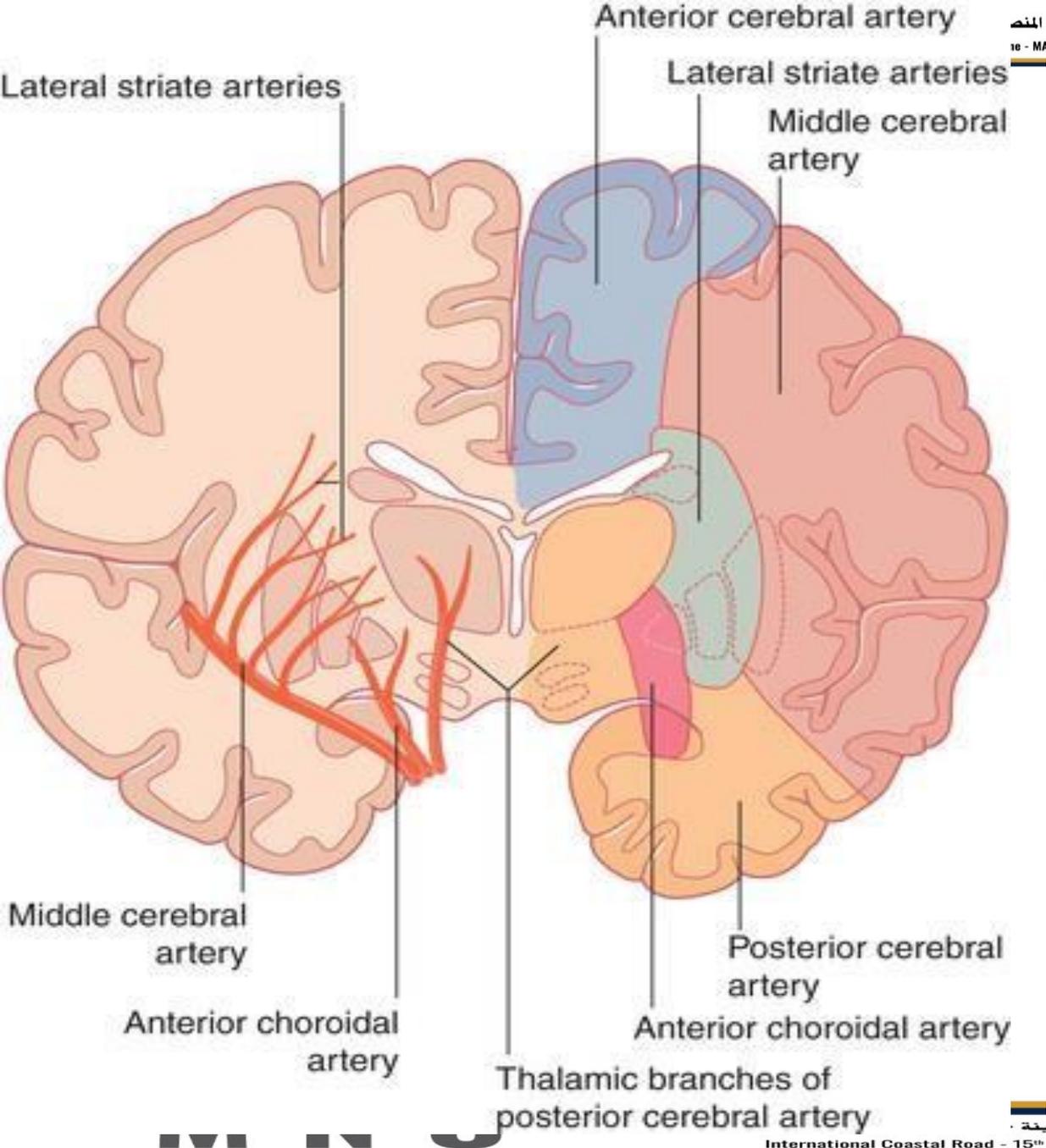
Clinical Note:

☐ Occlusion of the posterior cerebral artery causes **contralateral homonymous hemianopia** with macular sparing.

SAQ

B S OF CORPUS CALLOSUM
ACA
PCA





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Middle cerebral artery (MCA)

Origin: one of the two terminal branches of the internal carotid artery (it is **the larger one**). This is the largest and most direct of the branches of the internal carotid artery and is therefore the most prone to embolism.

Course:

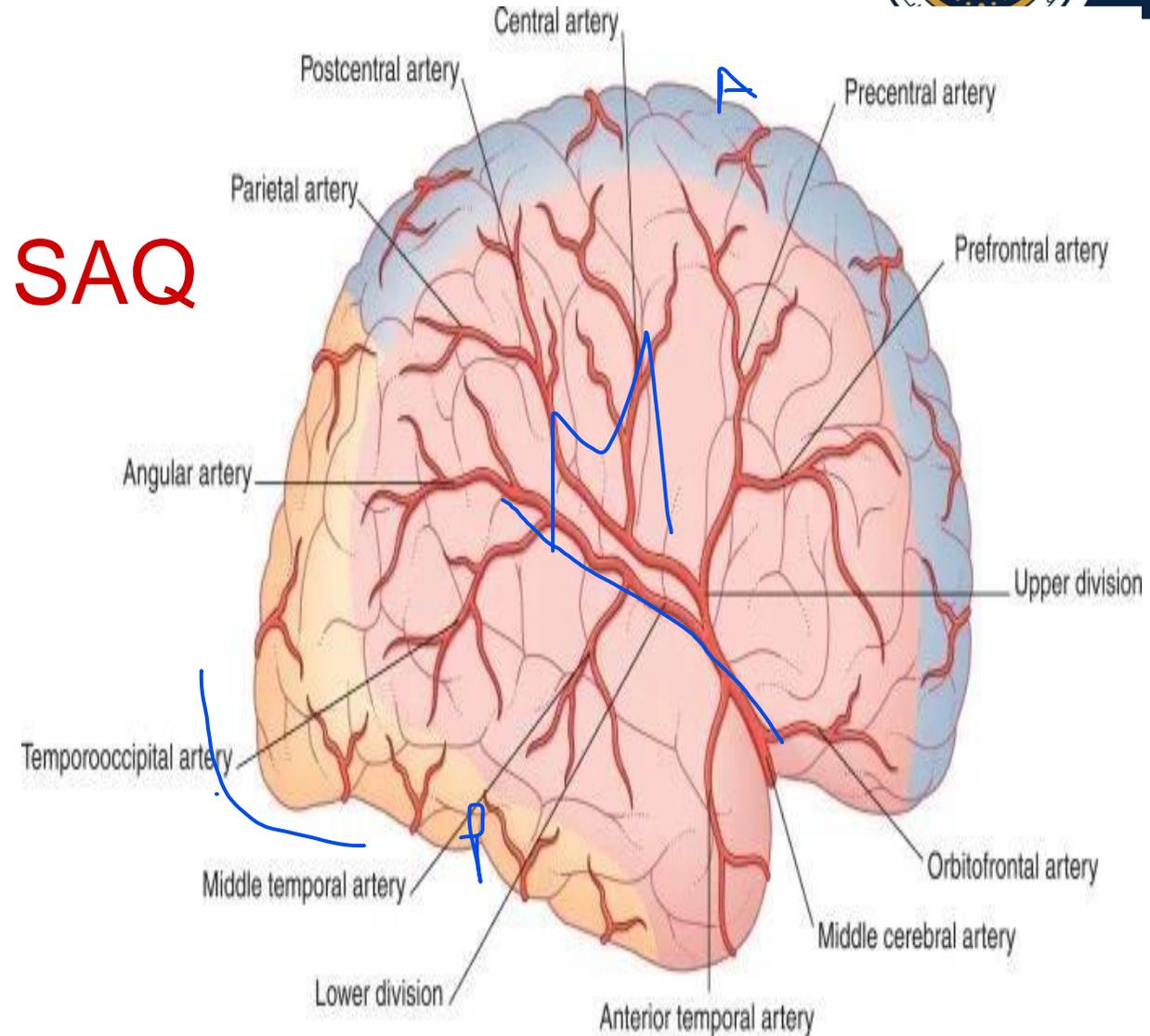
Passes in the lateral sulcus Ends on the surface of the insula by dividing into terminal branches.

Branches:

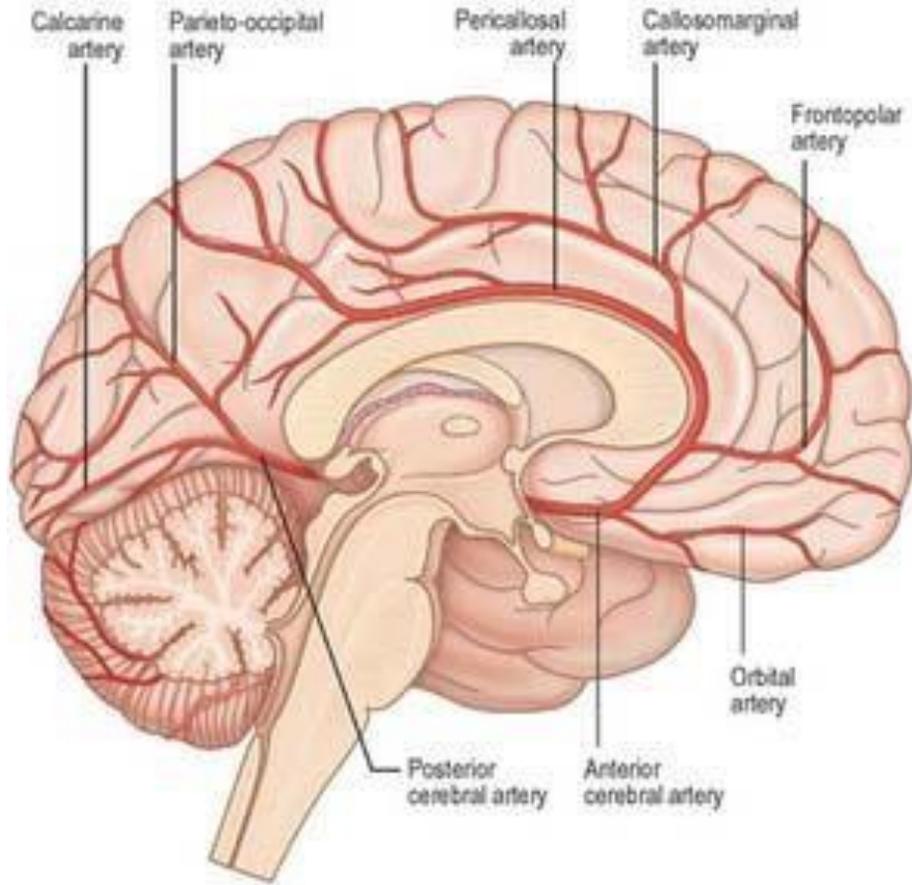
1. Cortical branches: supply:

- Passes in the lateral sulcus
- Ends on the surface of the insula by dividing into terminal branches.
- Upper division
- Lower division
- Anterior temporal artery
- Middle cerebral artery
- Orbitofrontal artery
- Middle temporal artery
- Temporooccipital artery
- Angular artery
- Parietal artery
- Postcentral artery
- Central artery
- Precentral artery
- Prefrontal artery

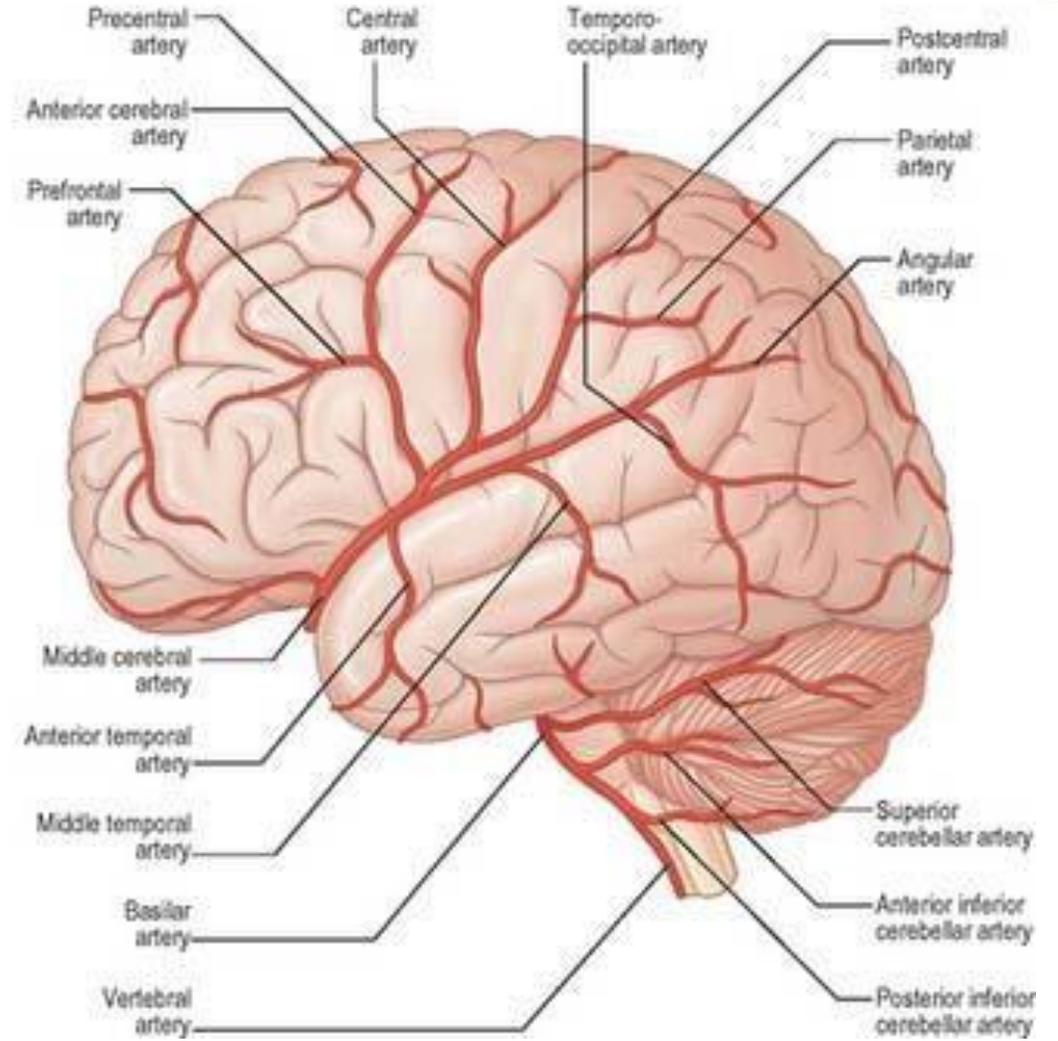
SAQ



A



B



Central branches (lateral striate arteries):

One of these arteries is large, liable to rupture and called **artery of cerebral hemorrhage**

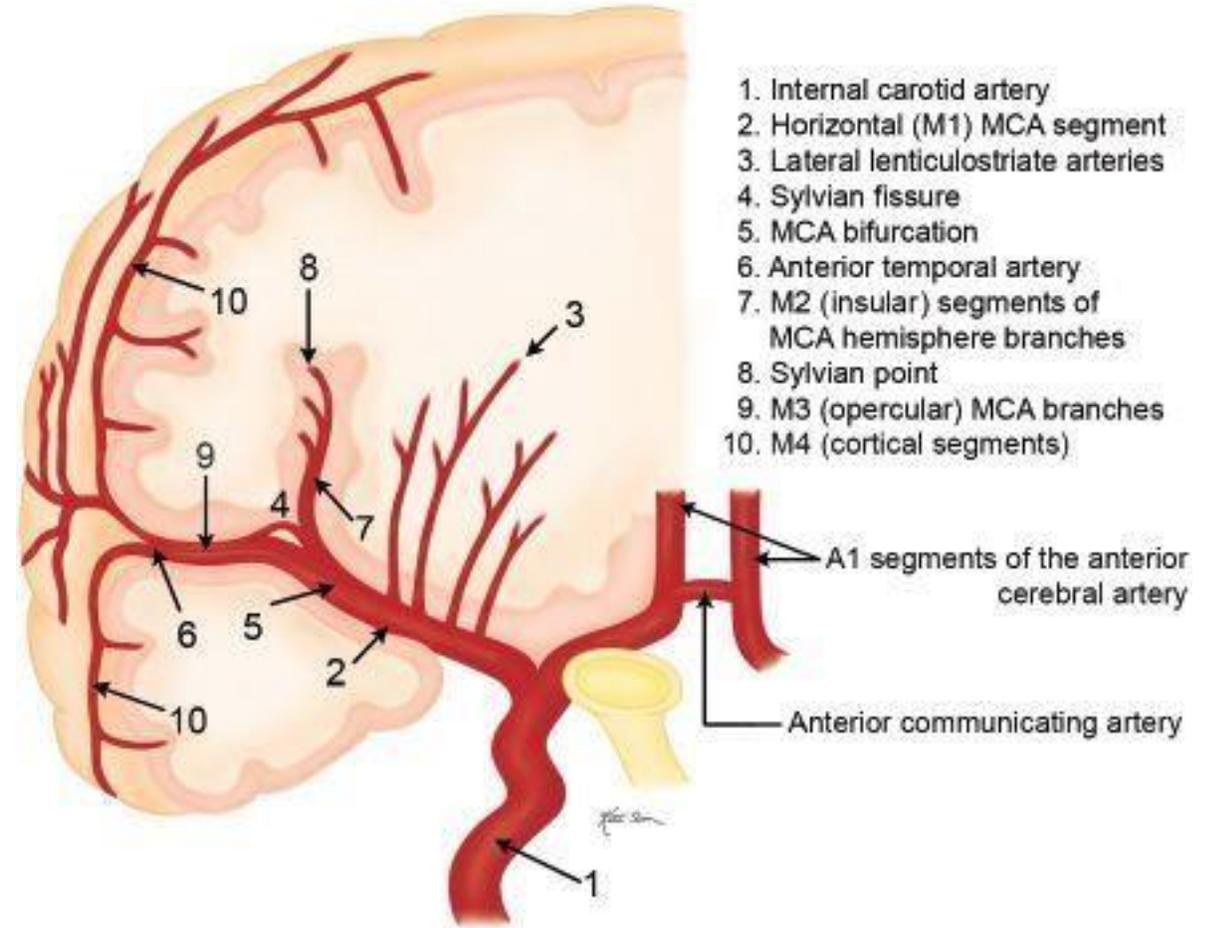
The central branches pierce the **anterior perforated substance** and supply the:

- Anterior and posterior limbs of the internal capsule.
- Posterior part of the corpus striatum except the tail of the caudate nucleus.

Important Cortical Areas Supplied by the MCA:

- Motor, premotor and general sensory areas except the **leg area (upper inch)**.
- Auditory and auditory association areas.
- Motor speech area (Broca's area) and sensory speech areas.

Middle Cerebral Artery
Coronal View



- Internal carotid artery
- Horizontal (M1) MCA segment
- Lateral lenticulostriate arteries
- Sylvian fissure
- MCA bifurcation
- Anterior temporal artery
- M2 (insular) segments of MCA hemisphere branches
- Sylvian point
- M3 (opercular) MCA branches
- M4 (cortical segments)

A1 segments of the anterior cerebral artery

Anterior communicating artery

Arterial supply of the cerebral cortex

Lateral surface:

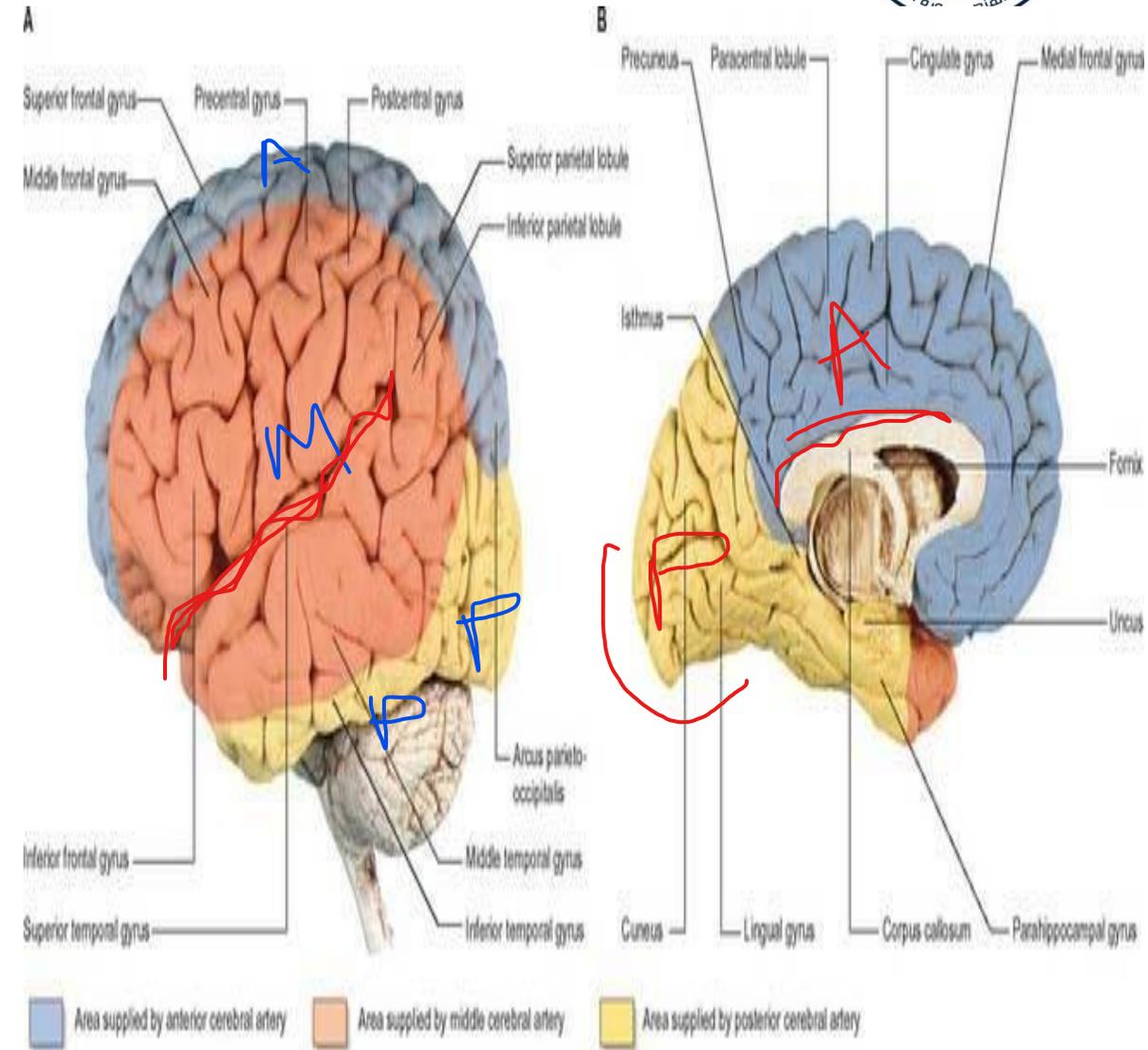
1. **Upper inch** of the frontal and parietal lobes: by the anterior cerebral artery.
2. **Occipital lobe and lower inch** (inferior temporal gyrus): by the posterior cerebral artery.
3. The rest of the lateral surface: by the middle cerebral artery.

Medial surface:

1. **Frontal and parietal lobes:** by the anterior cerebral artery.
2. **Occipital and temporal lobes** except the temporal pole: by the posterior cerebral artery.
3. **Temporal pole:** by the middle cerebral artery.

Inferior surface:

1. **Medial half** of the orbital surface: by the anterior cerebral artery.
2. **Lateral half** of the orbital surface and the temporal pole: by the middle cerebral artery.
3. **Tentorial surface** except the temporal pole: by the posterior cerebral artery.



Arterial supply of the internal capsule

ICA

Anterior Limb:

☐ Dorsal 1/2: middle cerebral artery.

☐ Ventral 1/2: anterior cerebral artery.

Genu:

☐ Anterior part: anterior cerebral artery.

☐ Posterior part: post communicating artery.

Posterior Limb:

☐ Dorsal half: middle cerebral artery.

☐ Ventral half:

1. Anterior 1/3: posterior communicating artery.

2. Posterior 2/3: Anterior choroidal artery.

IS THE MAIN BLOOD SUPPLY OF INTERNAL CAPSULE



Vertebral artery

Origin: it is a branch of the first part of the subclavian artery.

Course: 4 parts

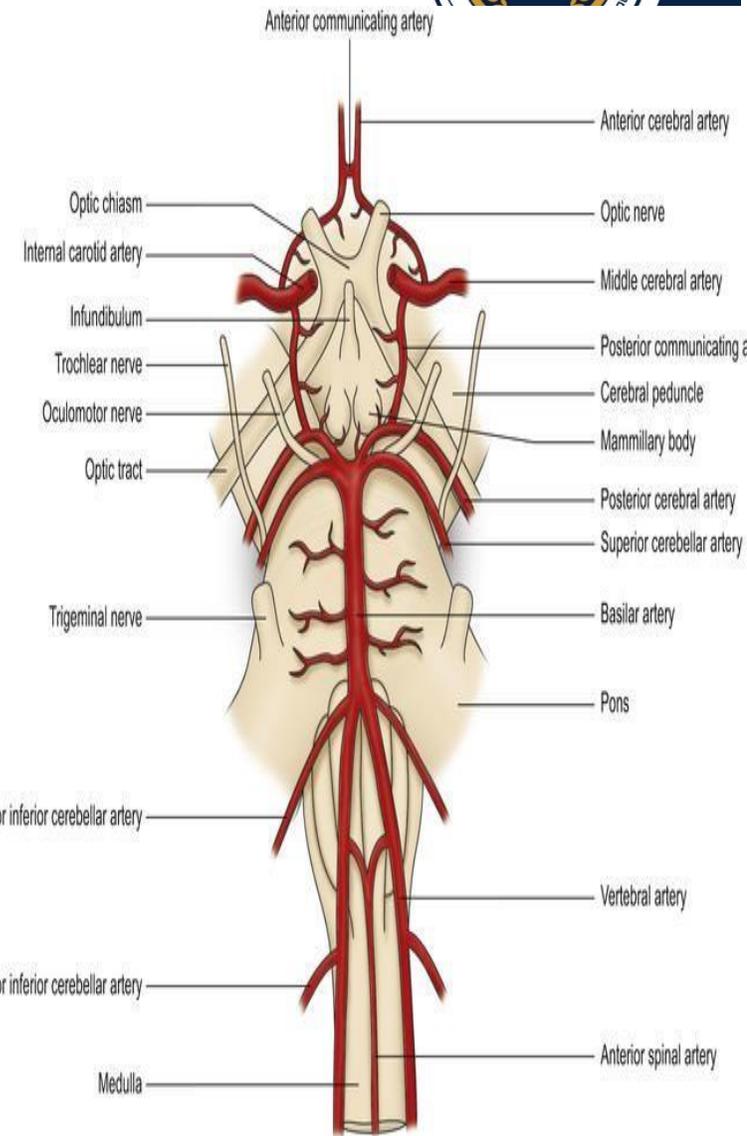
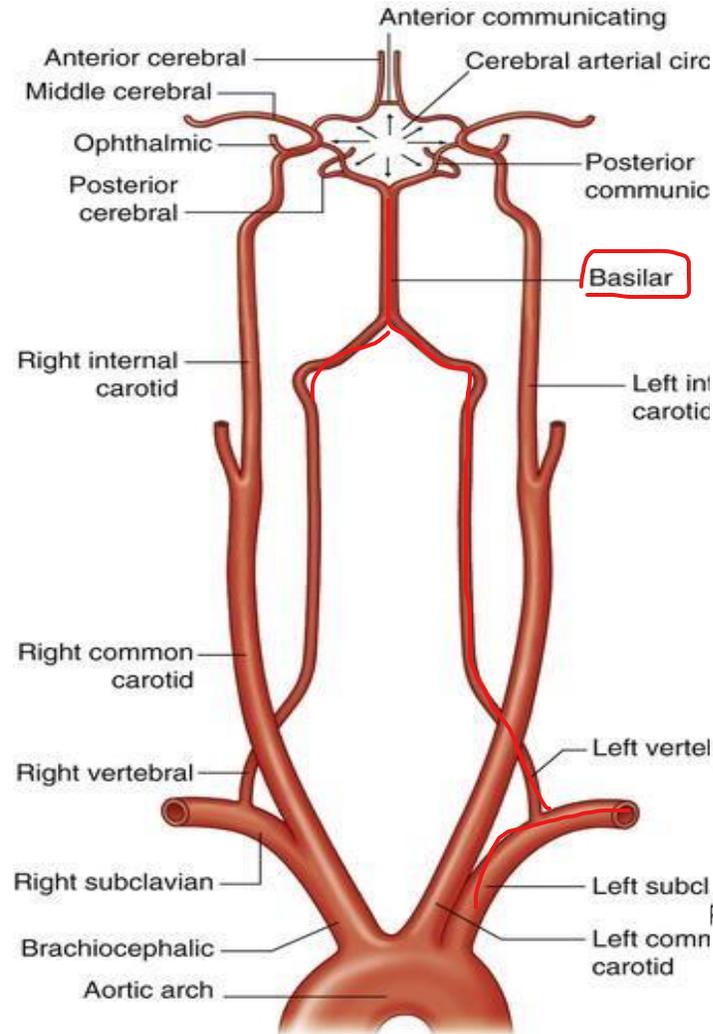
A. First part: from the origin to foramen transversarium of c6.

B. Second part: ascends through foramina transversaria of the upper six cervical vertebrae.

C. Third part: on the posterior arch of atlas.

D. Forth part enters the cranial cavity through foramen magnum. Ascends upward on the medulla to reach the lower border of the pons.

Termination: at the lower border of the pons where the **2 vertebral arteries** unite to form **the basilar artery.**



Vertebral artery

Branches in the cranial cavity:

1. **Anterior spinal artery:** It unites with the opposite one to form a single anterior spinal artery. It supplies:

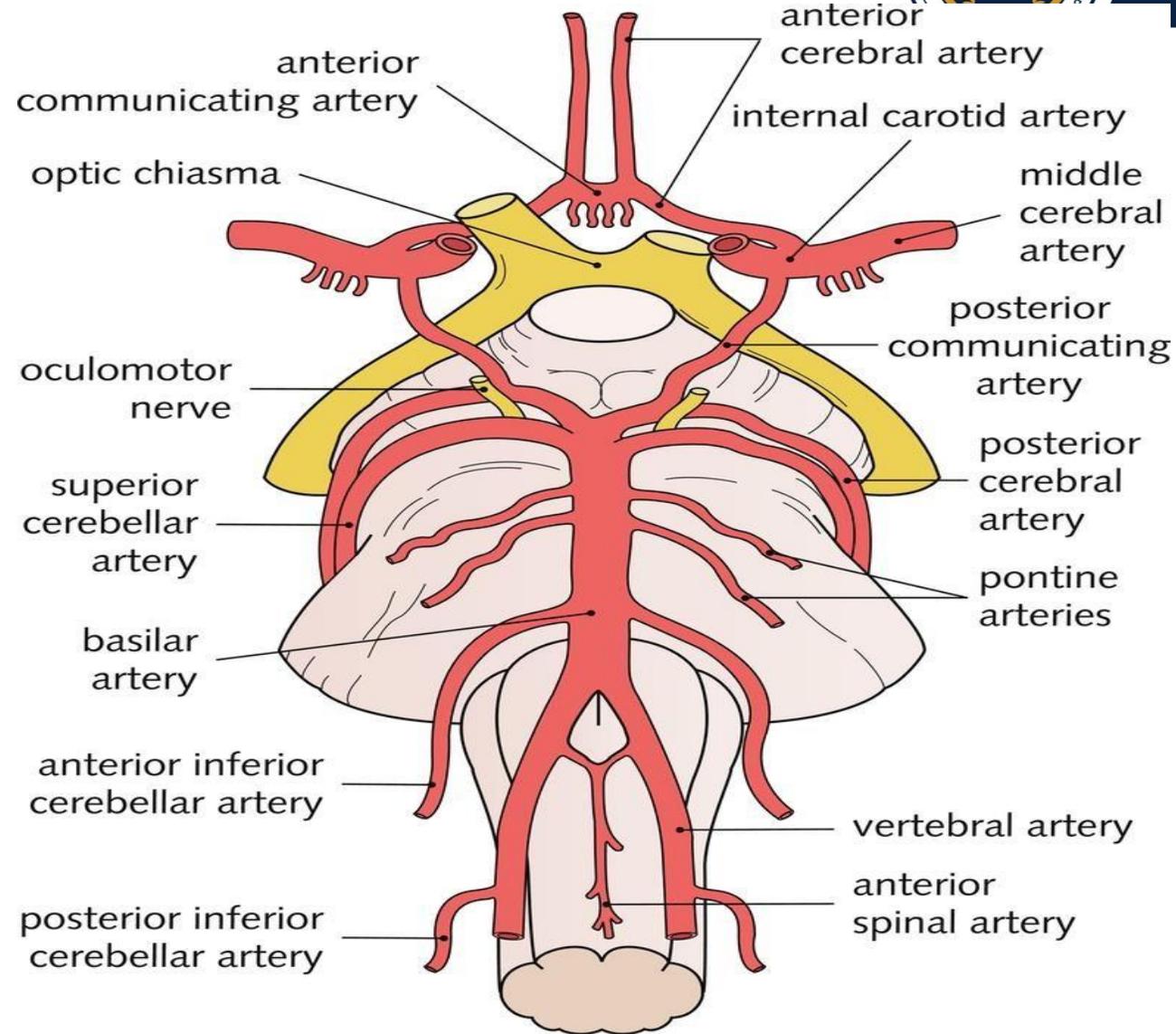
- o Anterior two-thirds of the spinal cord.
- o Medial zone of the medulla.

It **Occlusion of the anterior spinal artery** causes medial medullary syndrome.

2. **Posterior spinal artery:** Usually arises from the PICA. It supplies:

- It Posterior third of the spinal cord.
- It Gracile and cuneate tracts and nuclei.

3. **Medullary branches:** supply the middle zone of the medulla including the olive.



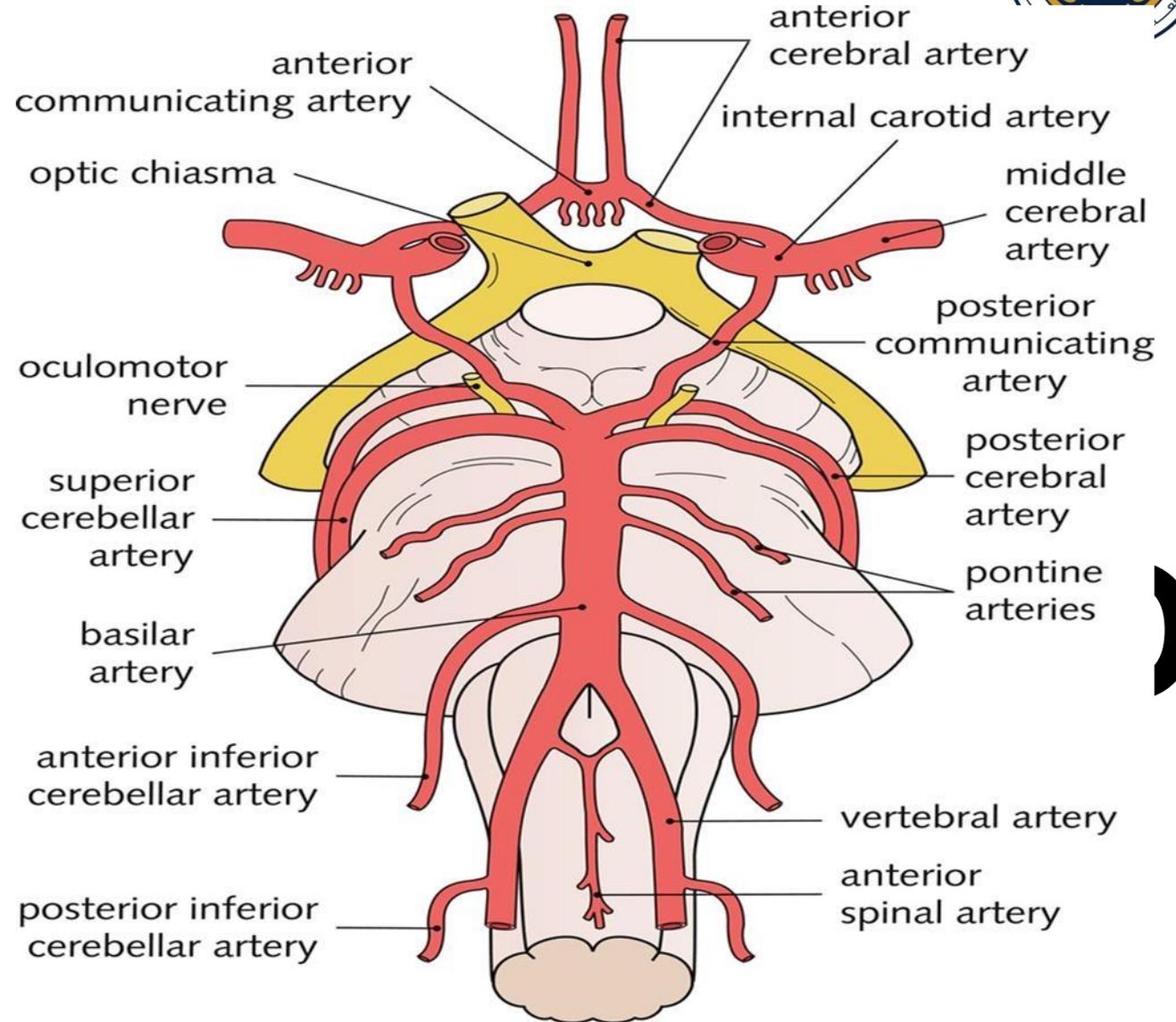
MCQ

4. Posterior inferior cerebellar artery (PICA): it supplies:

- a. Porsolateral zone of the medulla.
 - b. Inferior cerebellar peduncle.
 - c. Posterior part of the inferior surface of the cerebellum.
 - d. Choroid plexus of the 4th ventricle.
- ☐ It usually gives the posterior spinal artery.

☐ **Occlusion of the pica** causes lateral medullary syndrome.

5. Posterior meningeal artery: supplies the meninges of the posterior cranial fossa.



Basilar artery

Origin: at the **lower border of the pons** by the union of the two vertebral arteries.

Course: ascends in the basilar groove of the pons.

Termination: at **the upper border** of the pons by dividing into **2 posterior cerebral arteries**.

Branches: 1. **Pontine branches:** 3 groups

❑ **Paramedian branches:** to the medial zone of basis pontis.

❑ **Short circumferential branches:** to the lateral zone of basis pontis.

Long circumferential branches: to the pontine tegmentum.

2. **Anterior inferior cerebellar artery (AICA):** supplies:

❑ Anterior part of the inferior surface of the cerebellum.

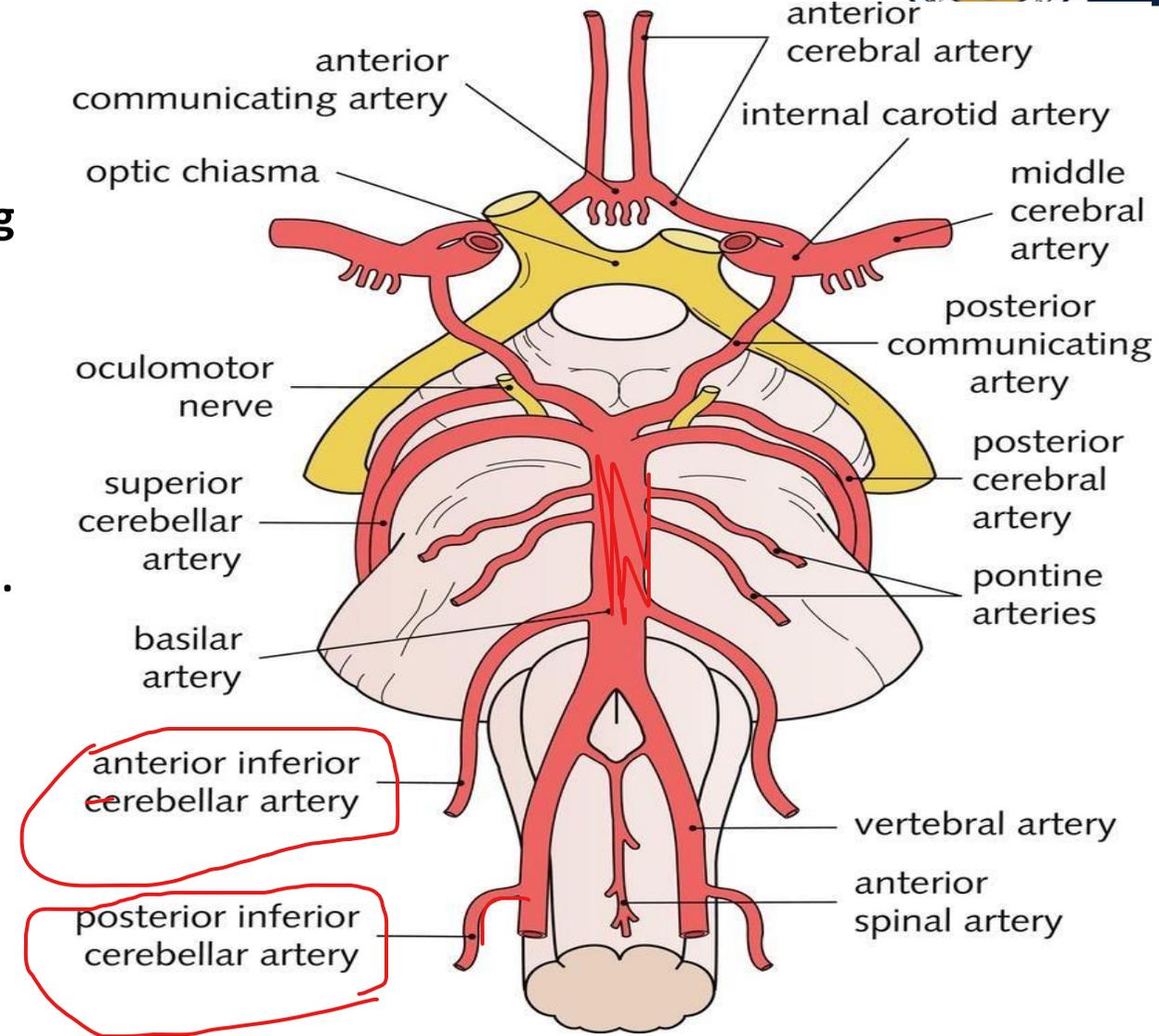
❑ Middle cerebellar peduncle.

❑ It gives the labyrinthine artery in 85%.

3. **Labyrinthine (internal auditory) artery (in 15%):**

❑ It accompanies the vestibulocochlear nerve and the facial nerve in the internal acoustic meatus

❑ **It supplies the internal ear.**



Basilar artery

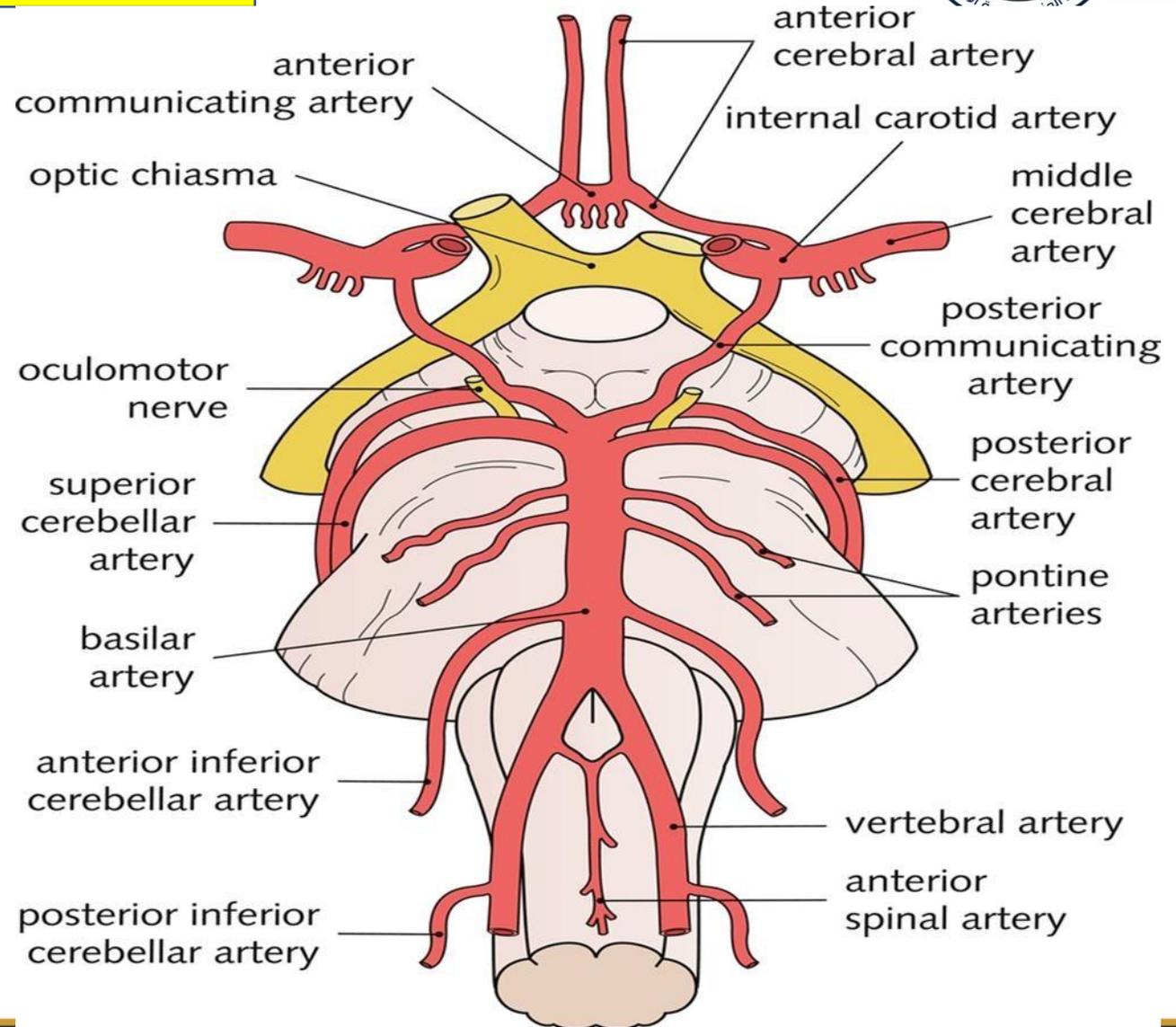
4. Superior cerebellar artery (SCA):

It winds around the midbrain and supplies:

- ☐ Superior surface of the **cerebellum**.
- ☐ Superior cerebellar peduncle and the superior medullary velum.
- ☐ Inferior colliculus of the midbrain.

5. Two terminal branches (posterior cerebral arteries):

- ☐ They wind around the midbrain.
- ☐ It is connected with the internal carotid artery by the posterior communicating artery.
- ☐ **It supplies** the midbrain, thalamus, hypothalamus and occipital lobe.
- ☐ It is separated from the superior cerebellar artery by the oculomotor & trochlear nerves.



Blood supply of the brain Arterial supply

Circulus arteriosus (circle of Willis)

Location: in the interpeduncular fossa at the base of the brain.

Formation: it is formed by the following arteries:

A. Anteriorly: anterior communicating artery connecting the two anterior cerebral arteries.

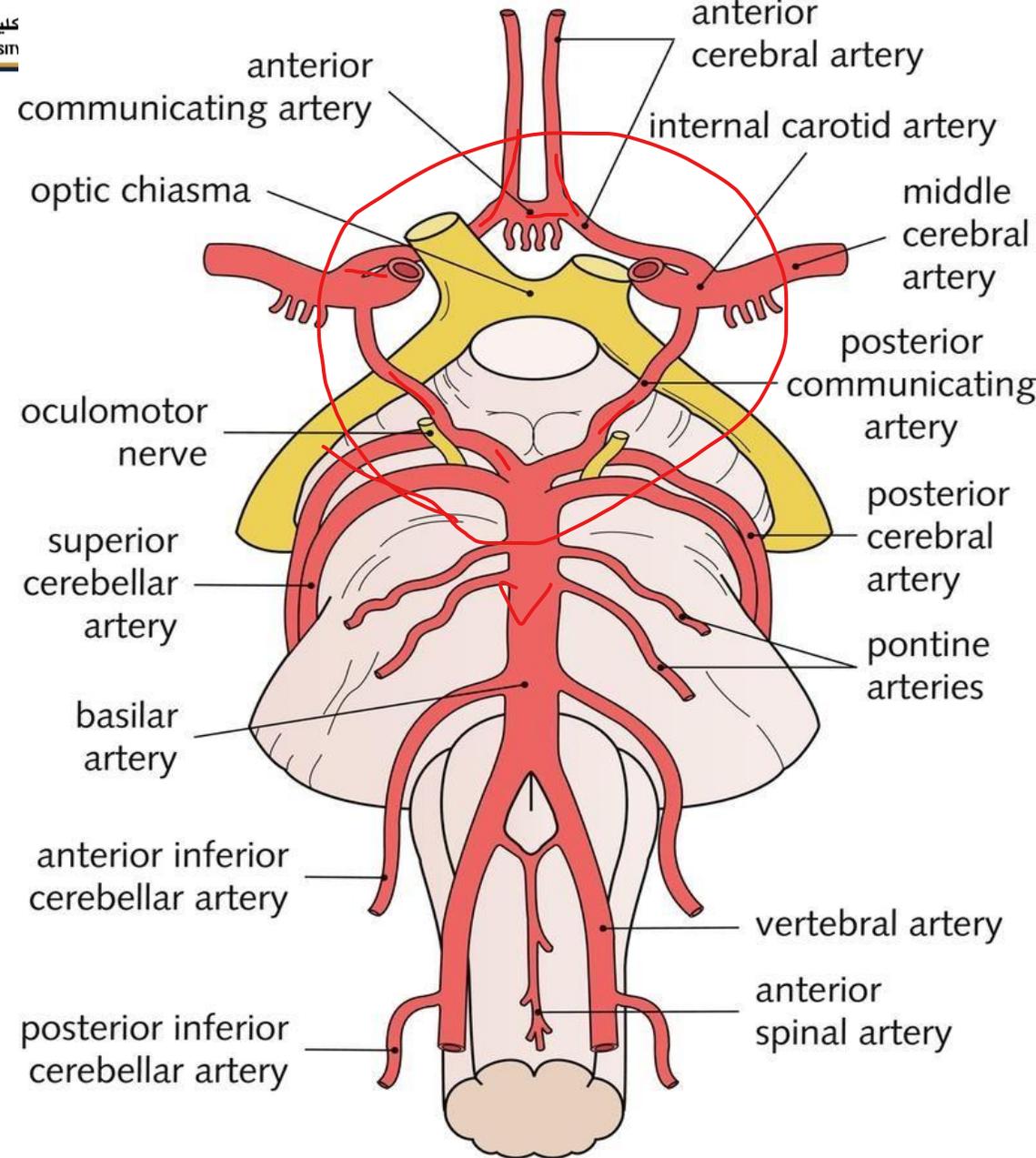
B. Posteriorly: two posterior cerebral arteries.

C. On each side: from before backward:

❑ **Anterior cerebral artery:** the smaller terminal branch of the internal carotid artery.

❑ **Internal carotid artery.**

❑ **Posterior communicating artery** connecting the internal carotid artery with the posterior cerebral artery.

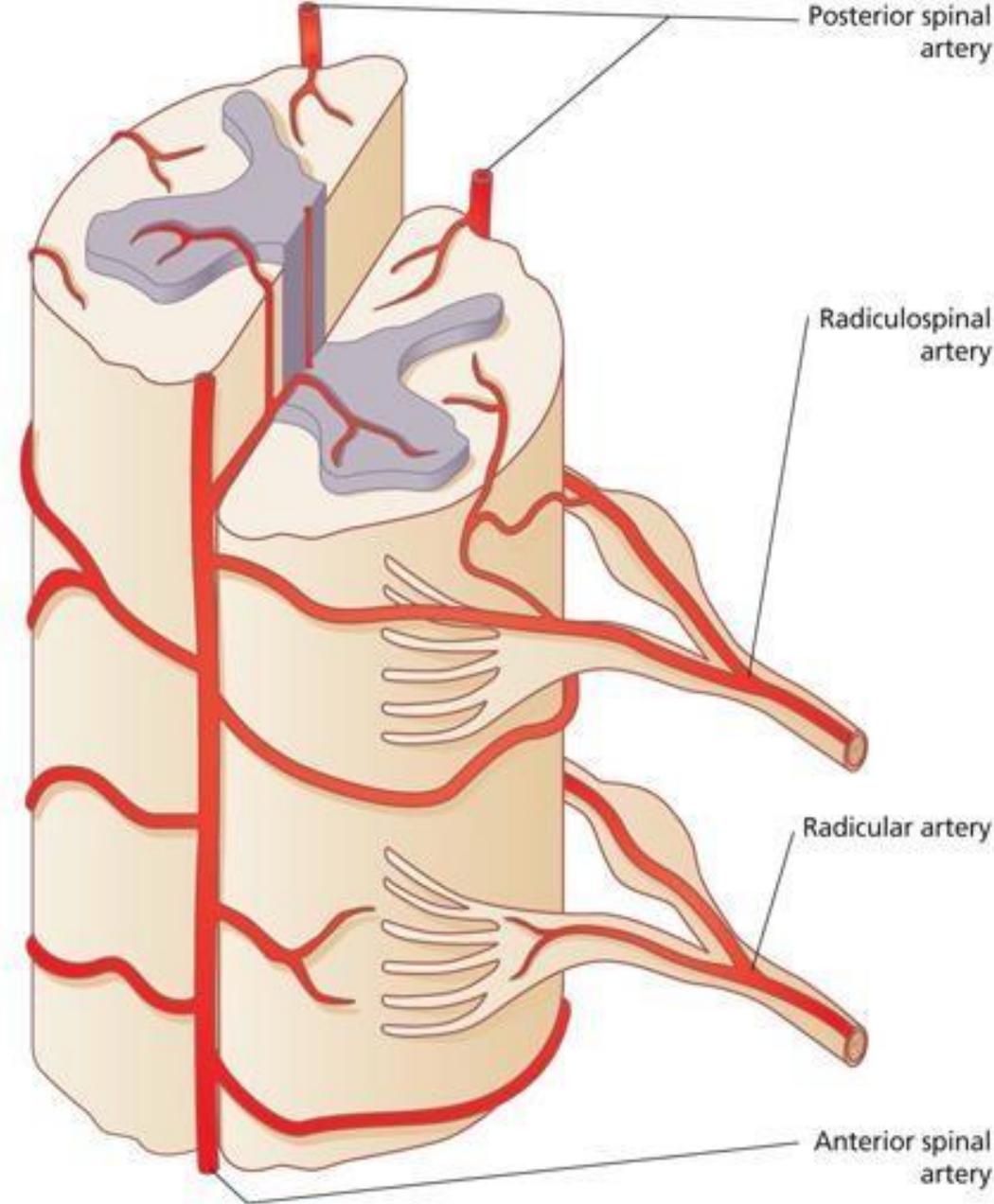


1. Anterior Spinal Artery:

- Is a single artery formed by the union of the two anterior spinal branches of the vertebral arteries. It descends in the anterior median fissure of the spinal cord.
- It supplies the **anterior 2/3 of the spinal cord.**
- It becomes very small below the cervical region & reinforced by **radicular arteries**

2. Two Posterior Spinal Arteries:

- Each is a branch of the vertebral artery or usually from the PICA.
- They descend along the dorsal nerve roots (posterolateral fissure).
- They supply the **posterior 1/3 of the spinal cord** (dorsal funiculus and horn).

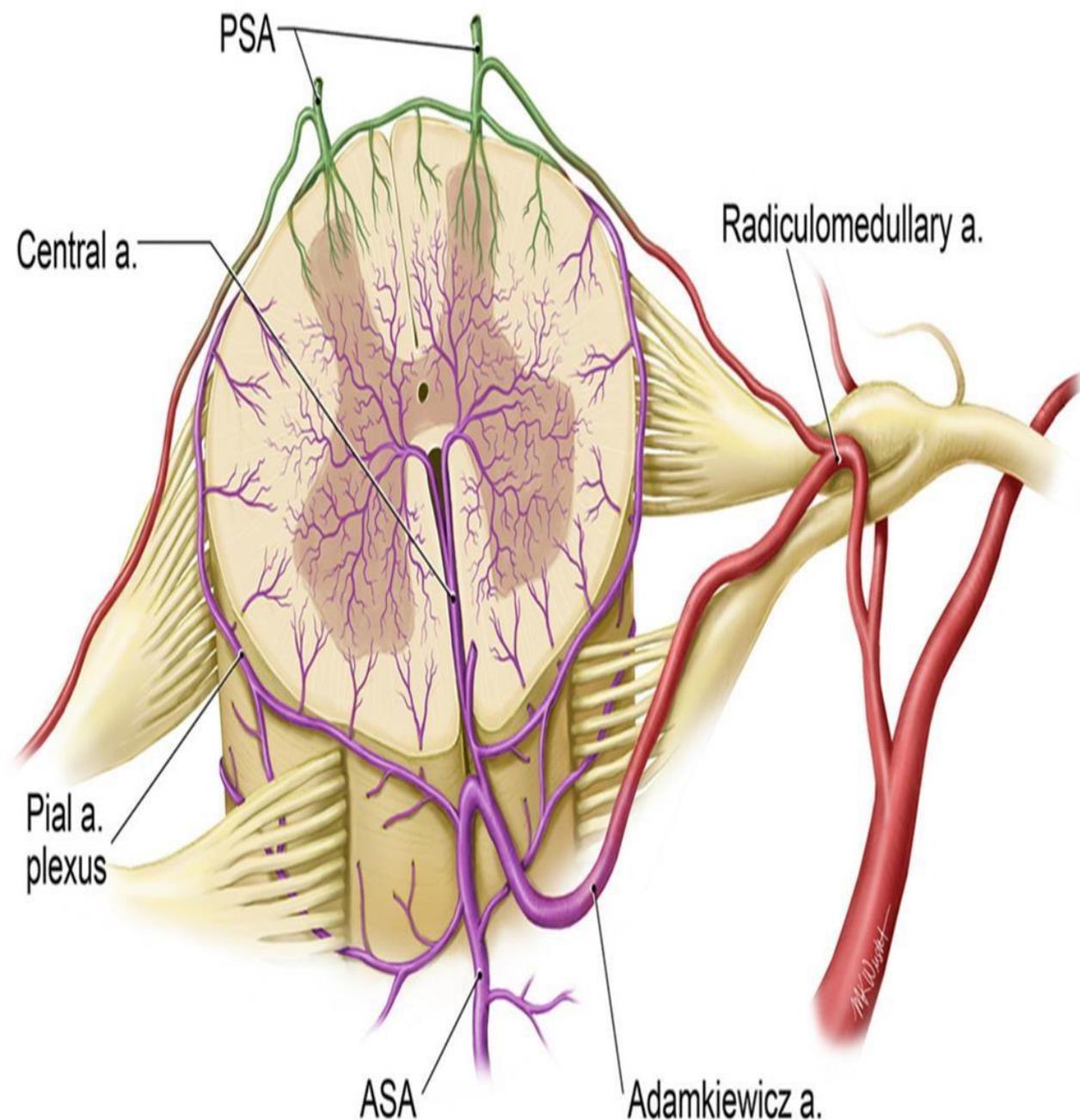


3. Radicular Arteries:

- They are the major source of blood to the lower two-thirds of the spinal cord.
- They enter the vertebral canal through the intervertebral foramina and divide into anterior and posterior branches which join the anterior & posterior spinal arteries.
- They are branches from:
 - ❓ In the neck: from the vertebral & ascending cervical arteries.
 - ❓ In the thorax: from the intercostal arteries.
 - ❓ In the abdomen: from the lumbar arteries.
 - ❓ In the pelvis: from the lateral sacral arteries.

Venous drainage of the spinal cord:

- The veins correspond to the arteries and drain into the internal vertebral venous plexus present in the epidural space.



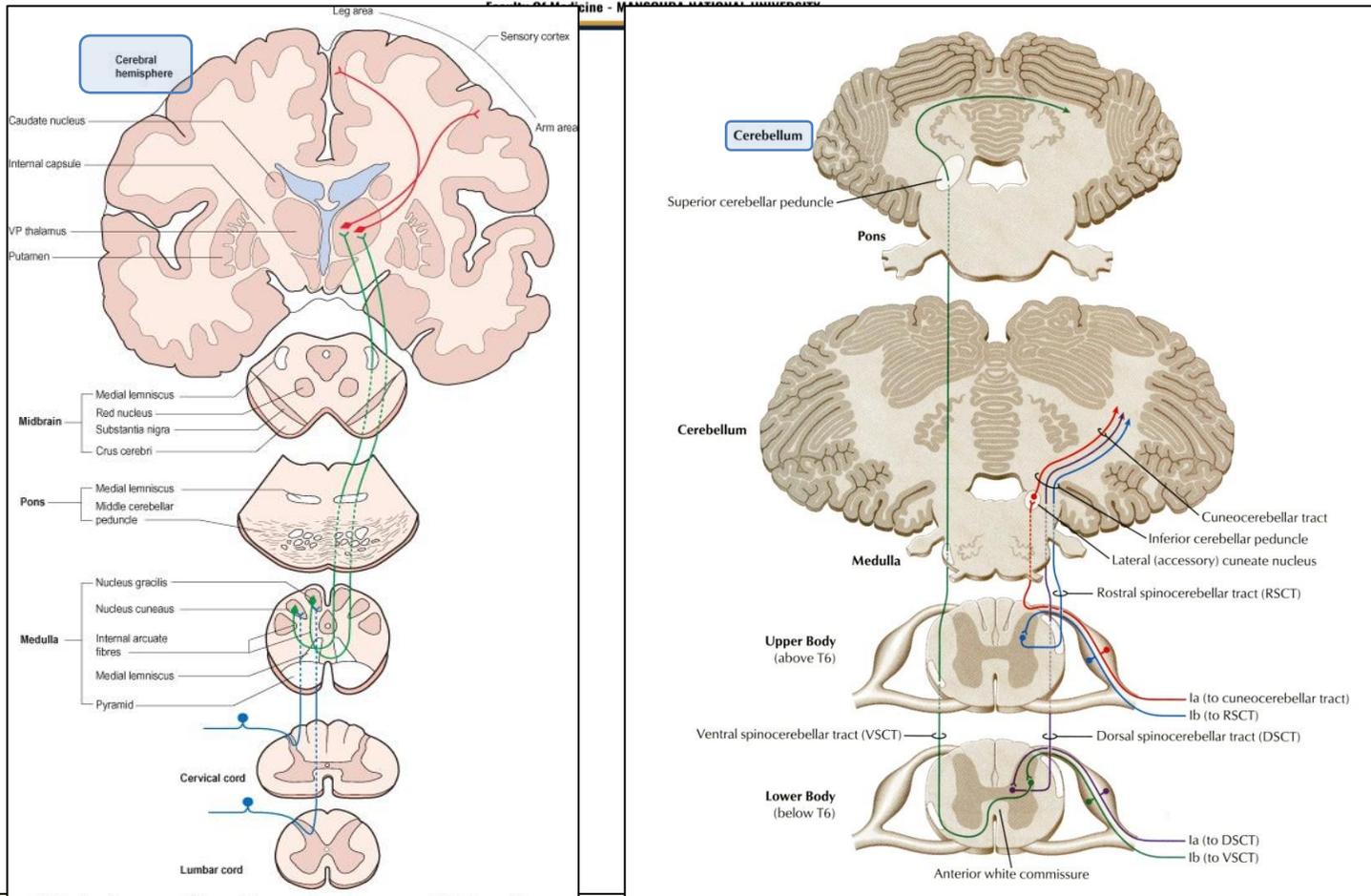


Sensory pathways Ascending Tracts

**Department of human Anatomy and Embryology
Faculty of Medicine
Mansoura National University, Egypt**

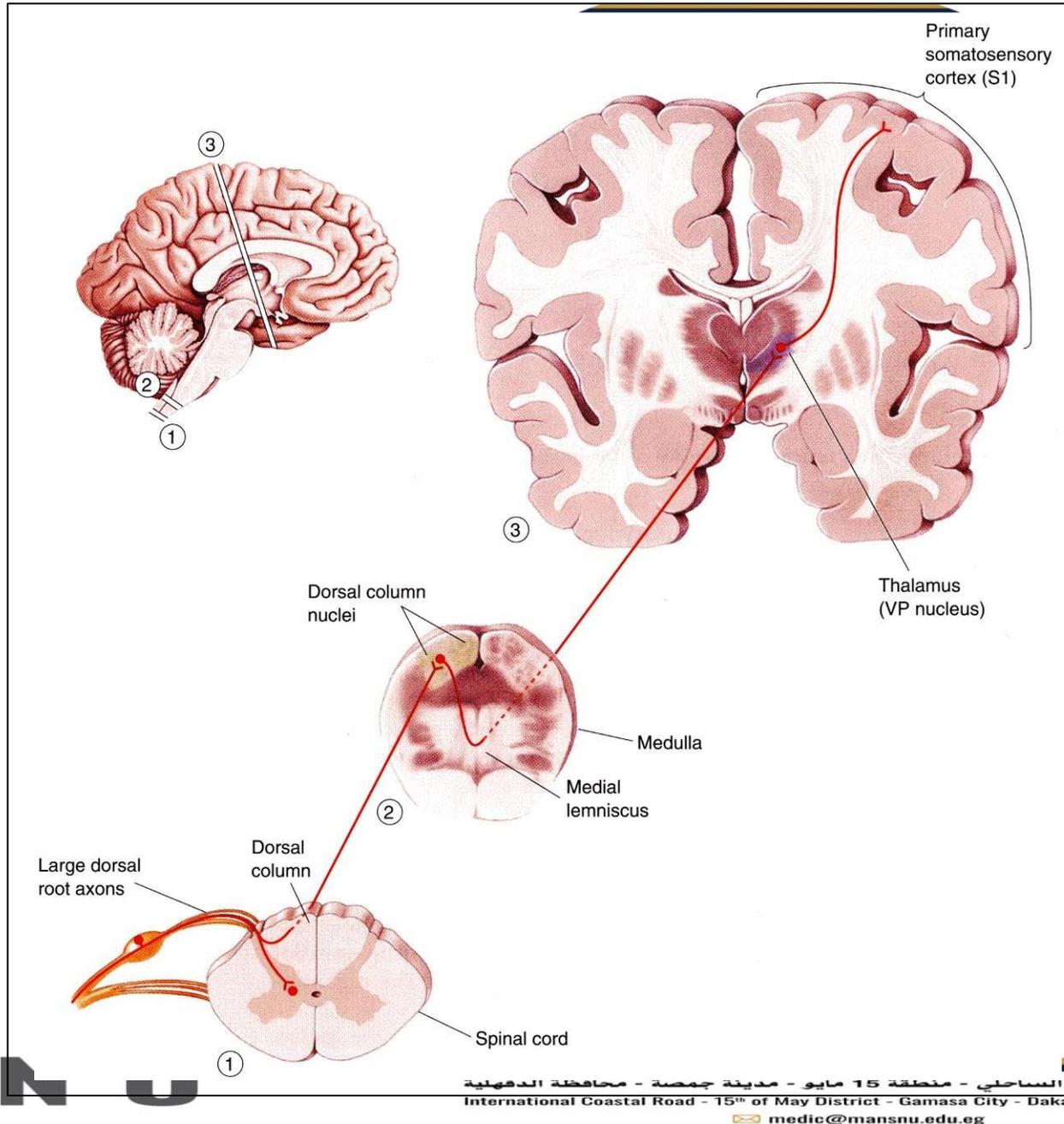
M N U





□ Ascending Tracts:

- Carry impulses from pain, thermal, tactile, muscle and joint receptors to the brain.
- *Some of this information eventually reaches a conscious level (at the cerebral cortex), while some is destined for subconscious centers (at the cerebellum).*



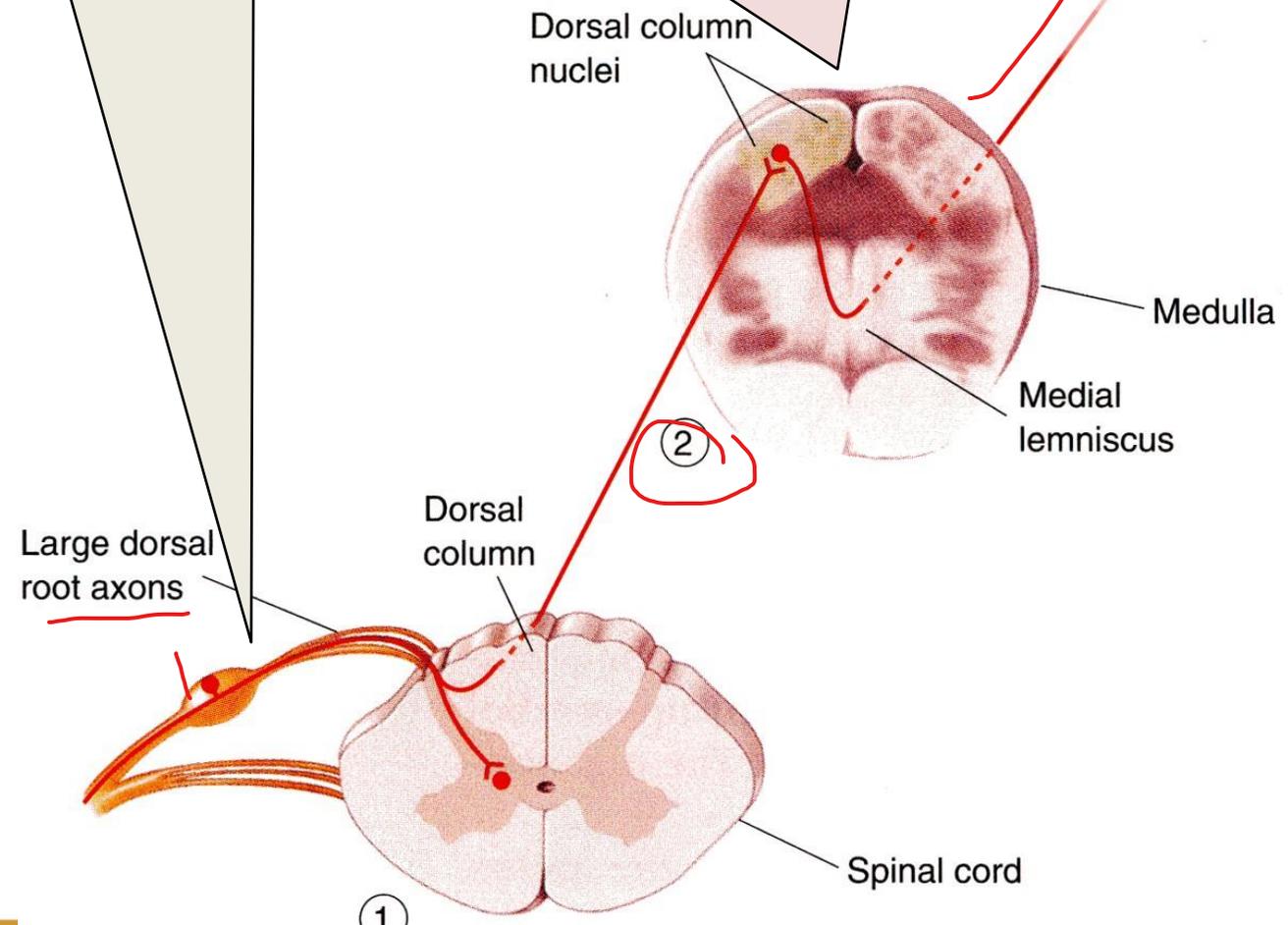
- Pathways that carry information to a **conscious level** share certain common characteristics:

There is a sequence of **Three Neurons** between the peripheral receptors and the cerebral cortex.

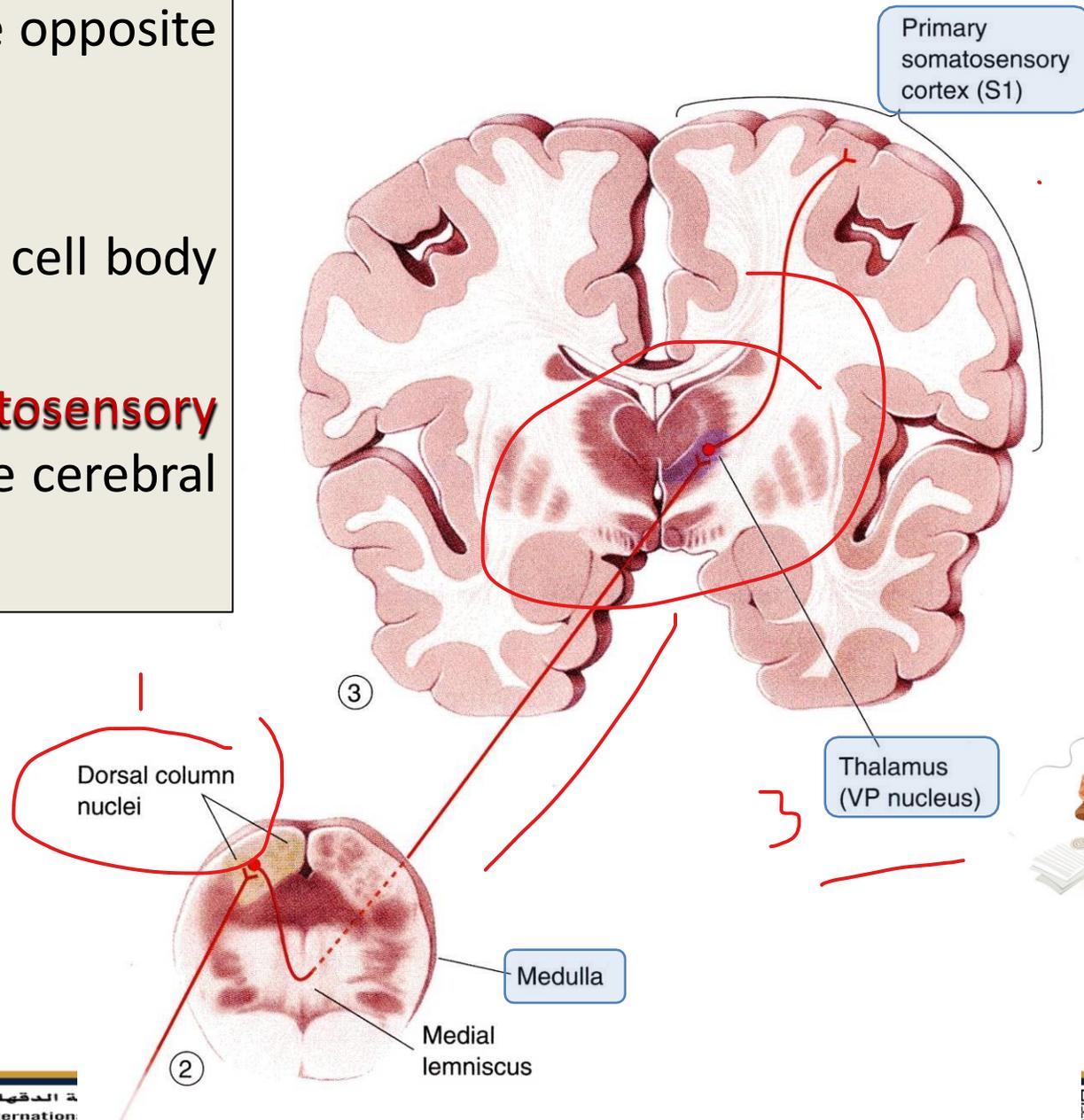
The axons of the **first-order neurone** (or primary afferent neurone) enters the spinal cord through the dorsal root of a spinal nerve and its cell body lies in the **dorsal root ganglion**.

The main fiber remains on the ipsilateral side of the cord and terminates in synaptic contact with the **second neuron which lies** either in the **spinal grey matter** or in the **medulla oblongata of the brain stem**.

DRG = 1ST
SGR = 2ND
THALAMUS = 3RD



- The axon of the **second order neuron crosses over (decussates)** to the opposite side of the CNS.
- **The third-order neurone** has its cell body in the **thalamus**.
- Its axon passes to the **somatosensory cortex** of the parietal lobe of the cerebral hemisphere.



The 3 ascending tracts are

Dorsal Columns

Vibration,

Fine Touch,

Proprioception

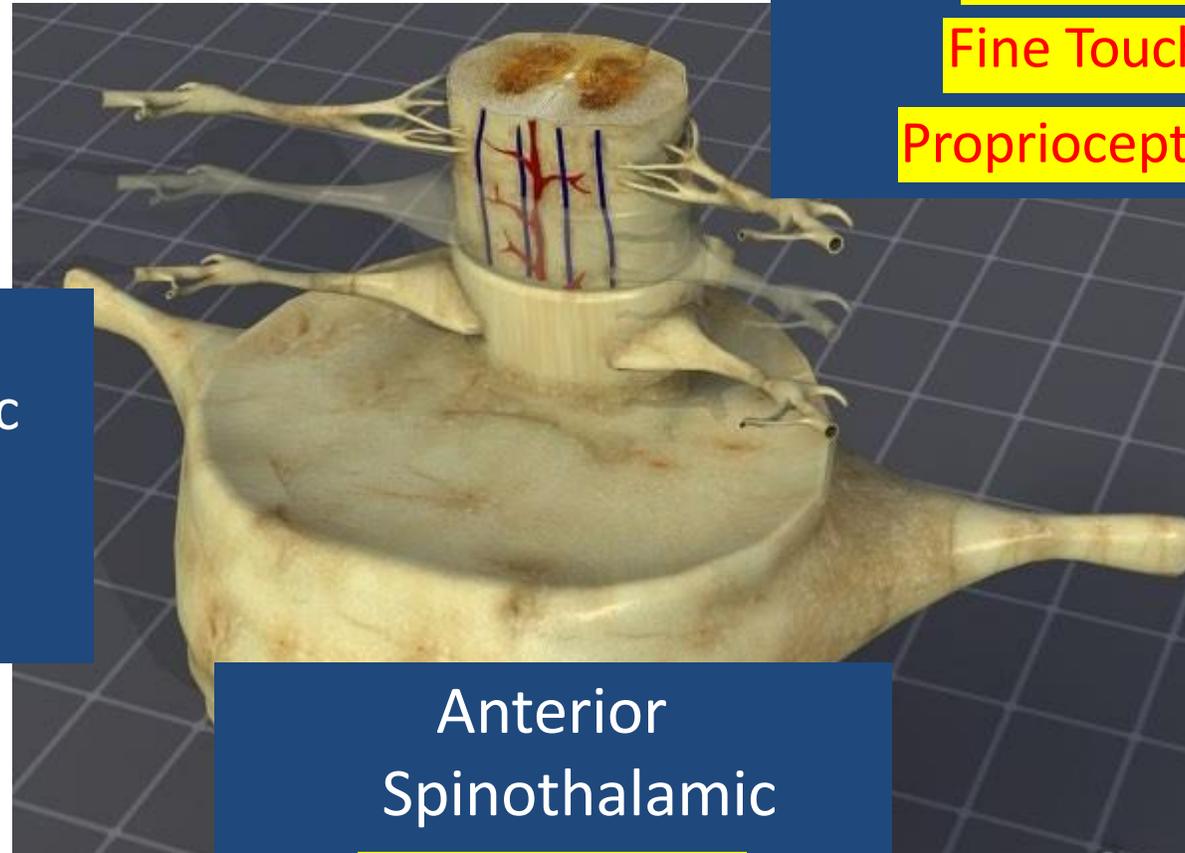
MCQ

Lateral Spinothalamic

Pain,

Temperature

MCQ



Anterior Spinothalamic

Crude touch,

Pressure

MCQ

Dorsal (Posterior)column (Gracile & Cuneate)

Vibration, Fine Touch,
Proprioception

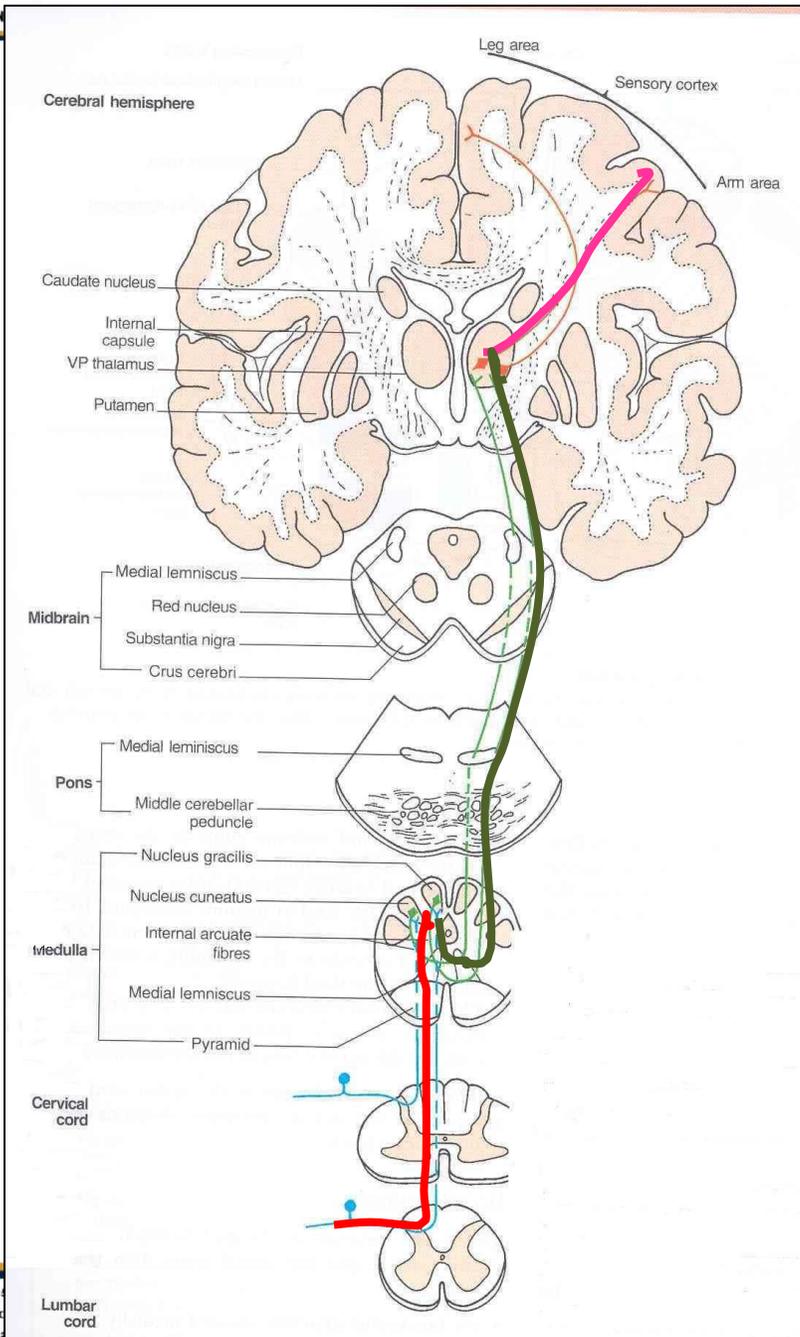
Dorsal Columns [Cross at Medulla]

3rd order neuron:
From VP nucleus in thalamus → through posterior limb of internal capsule → cortex

2nd order neuron:
From nuclei gracile and cuneate in medulla → in medulla → become internal arcuate fibers → ascend brainstem as the medial lemniscus → VPL nucleus of thalamus

1st order neuron:
From receptors in periphery → gracile and cuneate tracts → ascend to nuclei gracile and cuneate in medulla

DRCs





Spinothalamic pathway



Lateral Spinothalamic Tract

3rd order neuron:

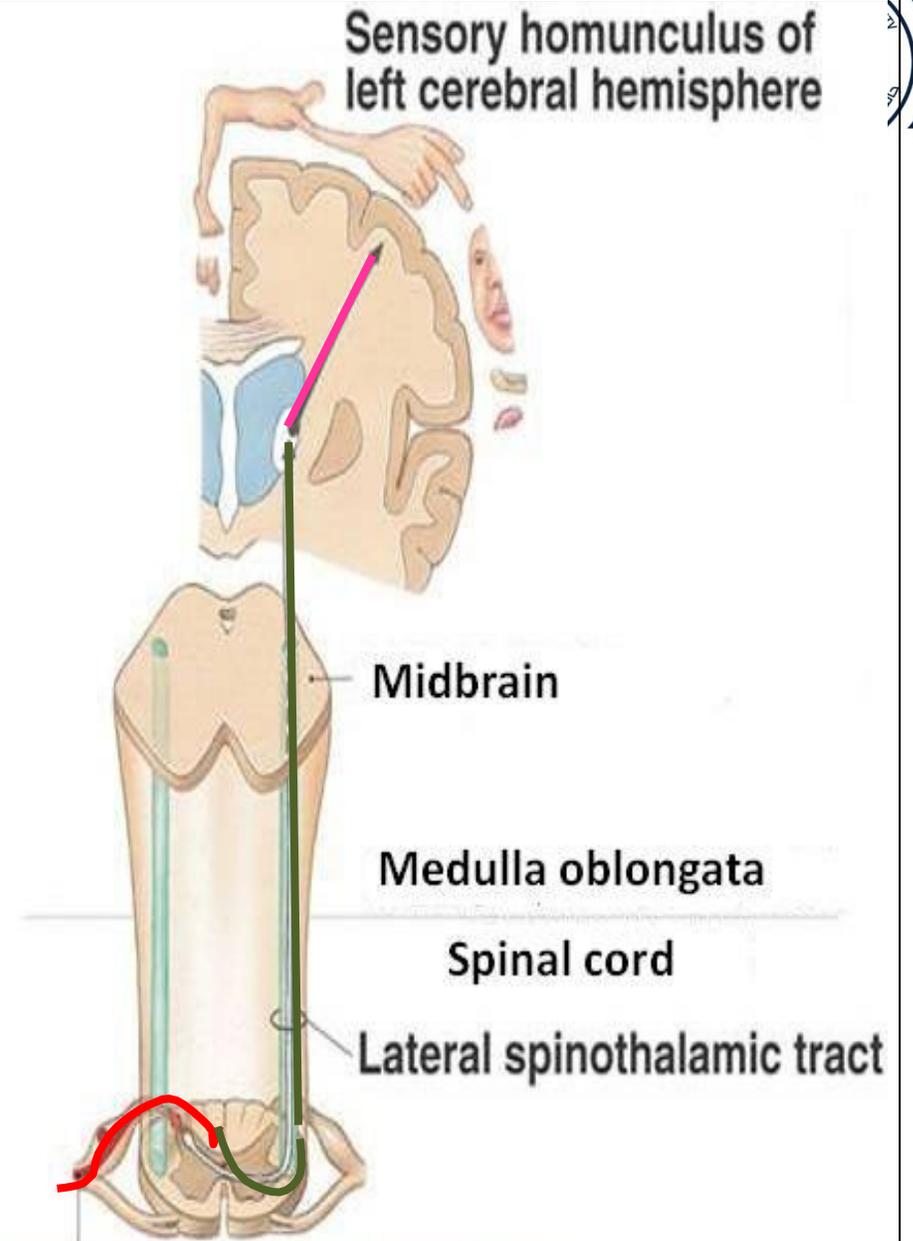
From VP nucleus in thalamus → through posterior limb of internal capsule → cortex

2nd order neuron:

From substantia gelatinosa → within 1 spinal segment and ascends in lateral Spinothalamic tract → spinal lemniscus in brainstem → ventral posterolateral (VP) nucleus in thalamus

1st order neuron: *DRG*

From receptors in periphery (fast (A) or slow (C) fibers) → substantia gelatinosa in dorsal horn



Pain and temperature sensations from right side of body

Function:

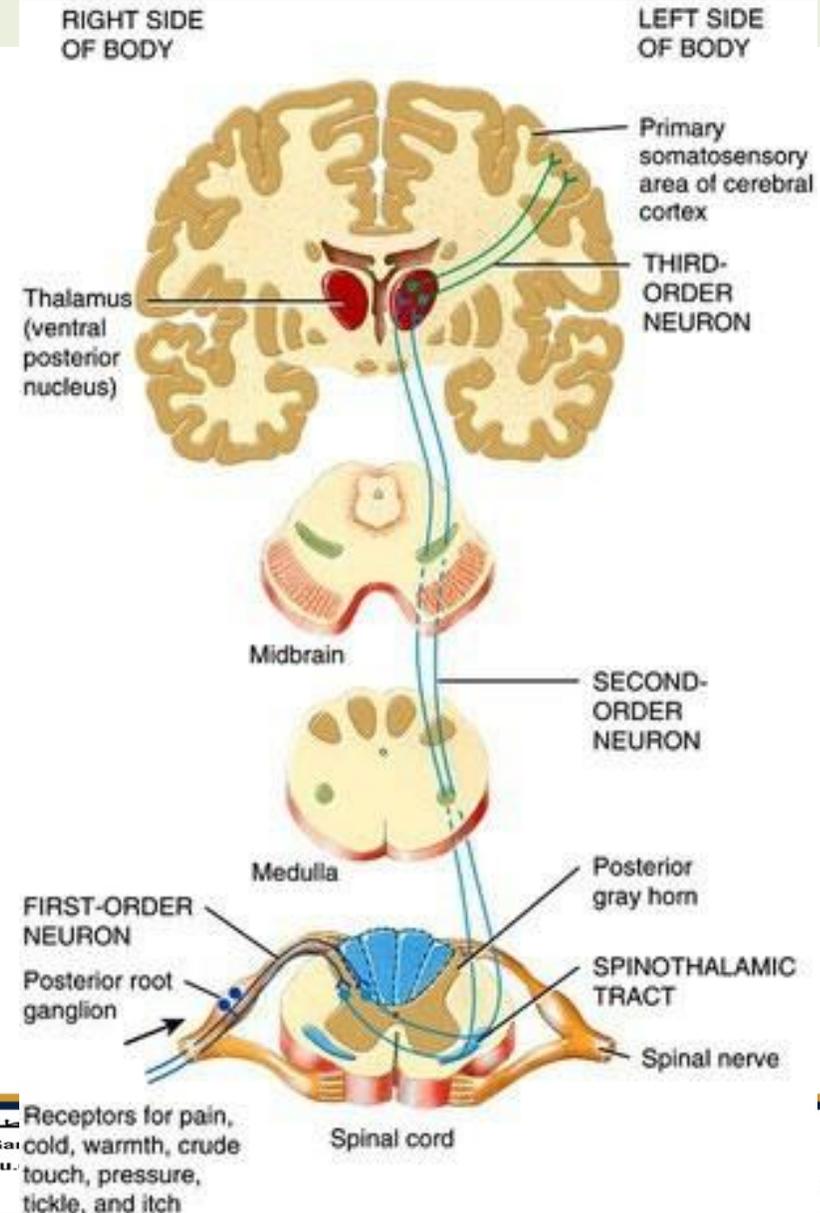
MCQ

Carries **pain & Temperature** to thalamus and sensory area of the cerebral cortex.

Neurons: 3 Neurons

- **Neuron I:** Small cells in the dorsal root ganglia.
- **Neuron II:** Cells of **substantia gelatinosa of Rolandi** in the posterior horn.
- **Neuron III:** Cells of **(VP) nucleus of the thalamus**.

Lateral Spino-thalamic Tract

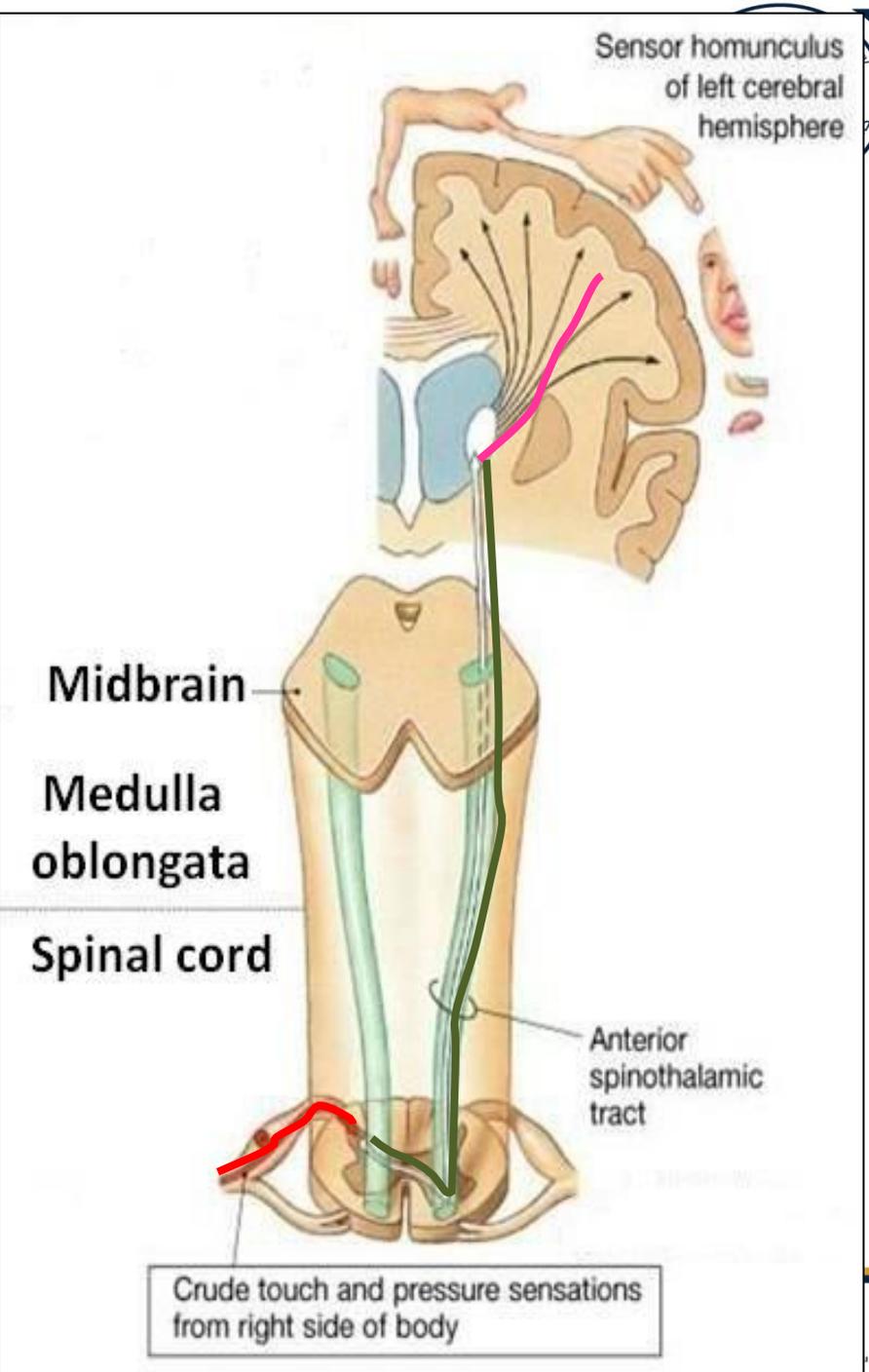


Anterior Spino-thalamic Tract

3rd order neuron:
From VP nucleus in thalamus → through posterior limb of internal capsule → cortex

2nd order neuron:
From substantia gelatinosa → over several spinal segments and ascends in anterior Spinothalamic tract → spinal lemniscus in brainstem → ventral posterolateral (VP) nucleus in thalamus

1st order neuron:
From various receptors in periphery → substantia gelatinosa in dorsal horn



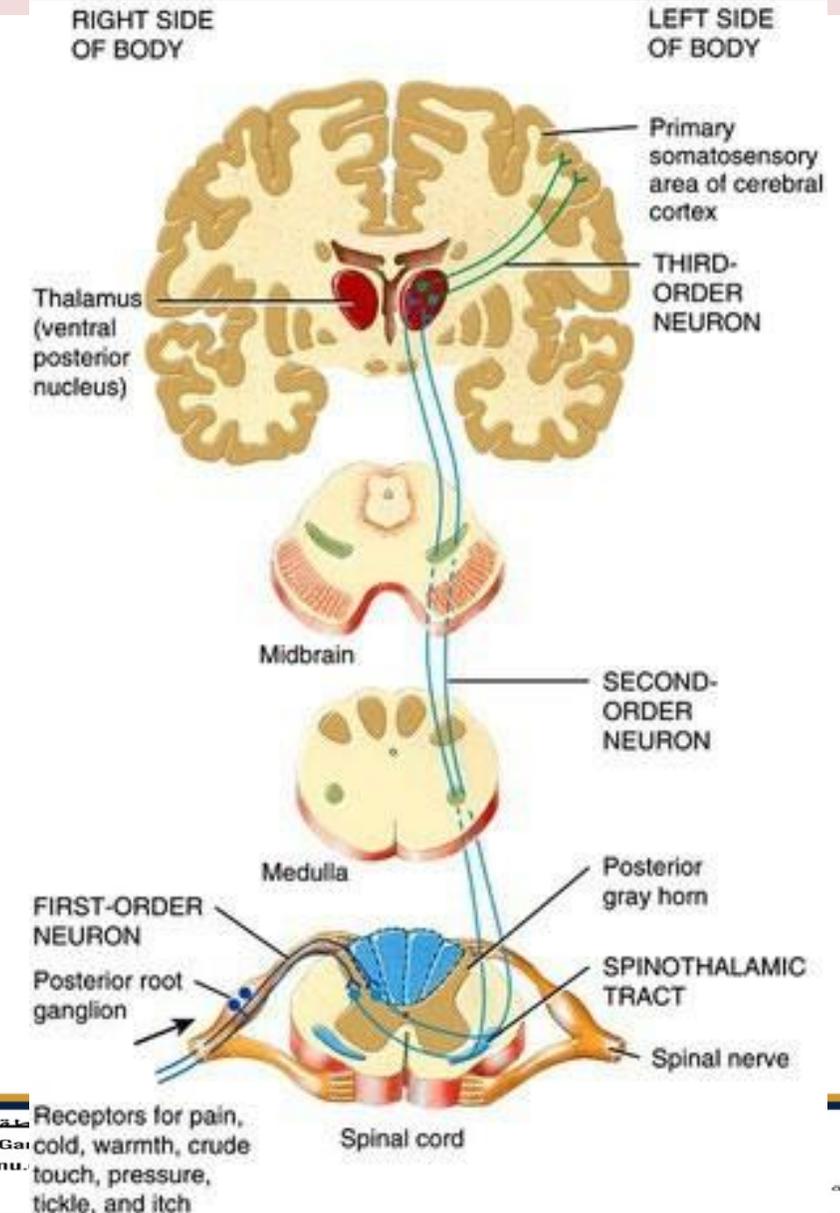
Anterior Spino-thalamic Tract

❑ Function: MCQ

Carries **crude touch (non discriminative) & pressure** to thalamus and sensory cortex.

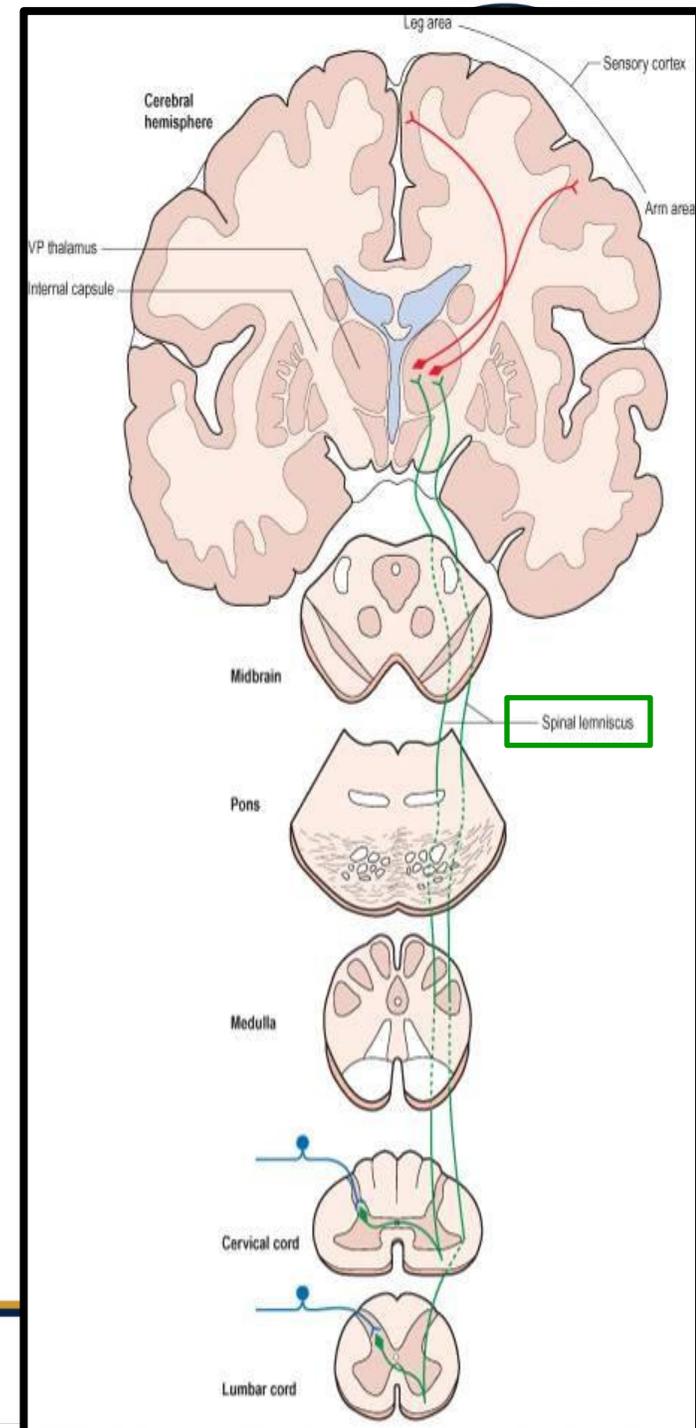
❑ Neurons: 3 Neurons

- **Neuron I:**
Medium sized cells in the dorsal root ganglia.
- **Neuron II:**
Cells of main sensory nucleus or (**nucleus proprius**).
- **Neuron III:**
Cells of VP nucleus of thalamus.



Spino-thalamic Tracts

- The spino-thalamic tracts contain axons of **second-order neurons**, the cell bodies of which lie in the **contralateral** dorsal horn.
- Carry impulses concerned with; **pain and thermal sensations (Lateral tract)** and **Non- Discriminative touch and pressure (Anterior tract)**, from the contralateral side.
- In brain stem, the two tracts constitute the **Spinal Lemniscus**.
- Information is sent to the primary sensory cortex on the opposite side of the body.





Spinocerebellar pathway

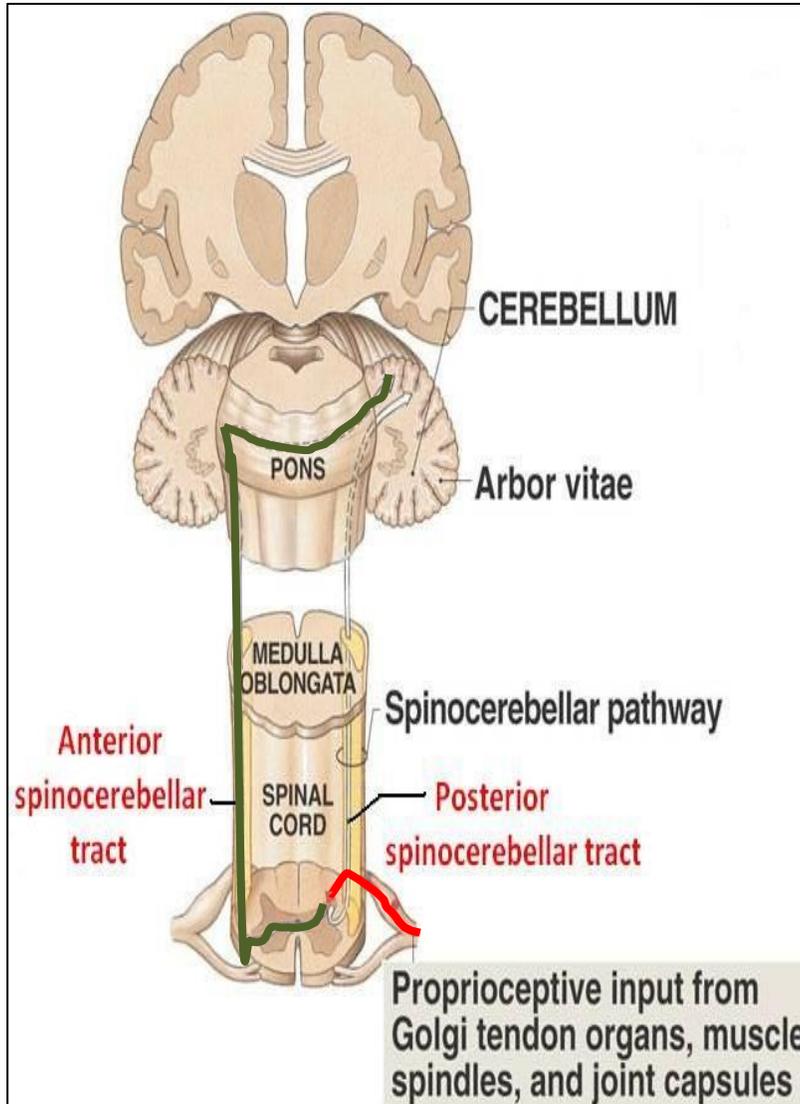
NO 3ED OEDER NEURONE
MCQ



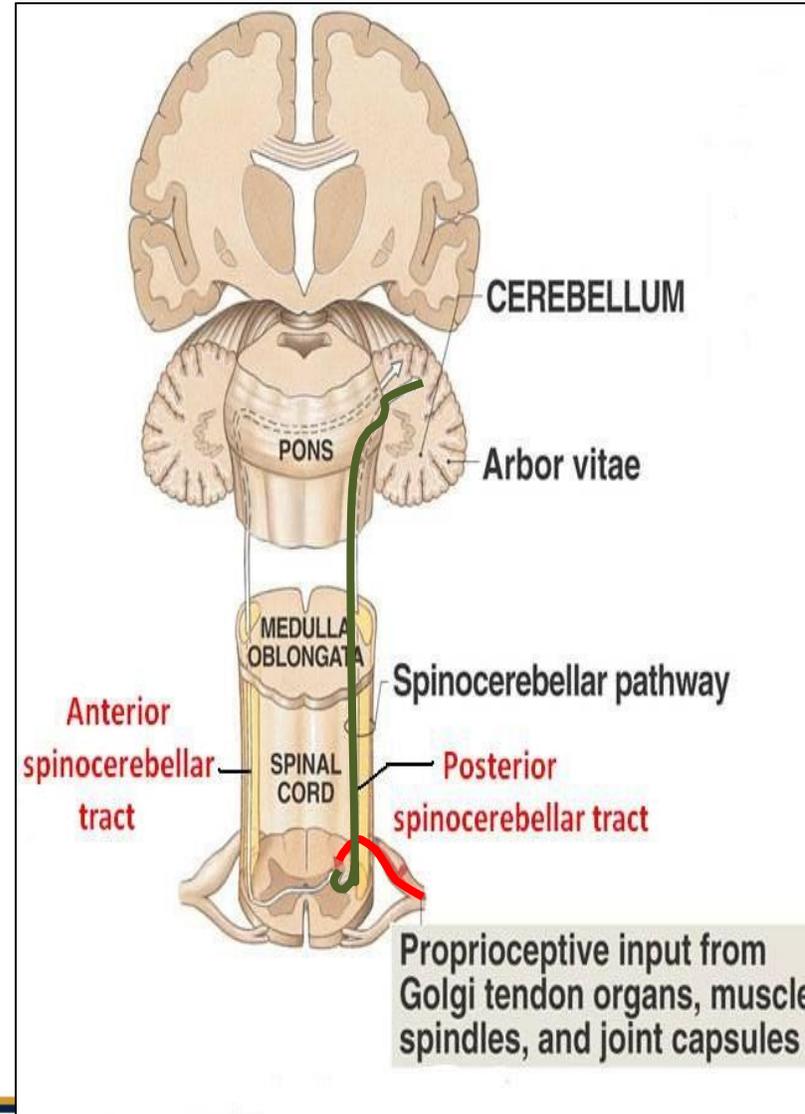
Ventral (Anterior) Spino-cerebellar Tract

Posterior (Dorsal) Spino-cerebellar Tract

The VSCT crosses twice



The DSCT Doesn't cross



Why doesn't the spinocerebellar tract have a 3rd neuron?

- There is **no 3rd order neuron** as it doesn't reach **consciousness** i.e., the cortex.



DESCENDING TRACTS

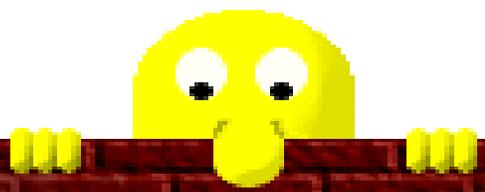
Motor Pathways

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Faculty of Medicine
Mansoura National University, Egypt



Edited By
Dr. Fekry Shata





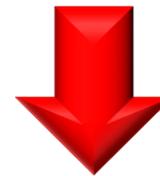
Motor Pathways

Descending tracts (Motor system)

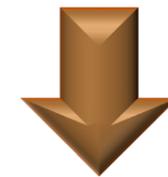
There are 3 different motor systems



**1- Pyramidal system:
(corticospinal tract
& corticobulbar tract)**



**2- Extrapyramidal
system**



**3- Motor
pathway to the
cerebellum**



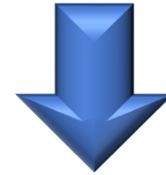
Pyramidal system



Pyramidal system

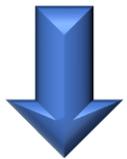


SAQ



Corticospinal tract

Corticobulbar tract
to cranial nerve motor nuclei



3,4,6,7,9,10,11,12

Lateral Corticospinal tract

Ventral Corticospinal tract



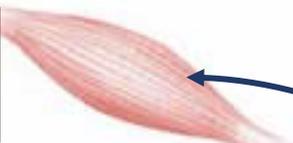
Pyramidal system

How to control your muscles?

Muscles of H&N



Muscles of the body

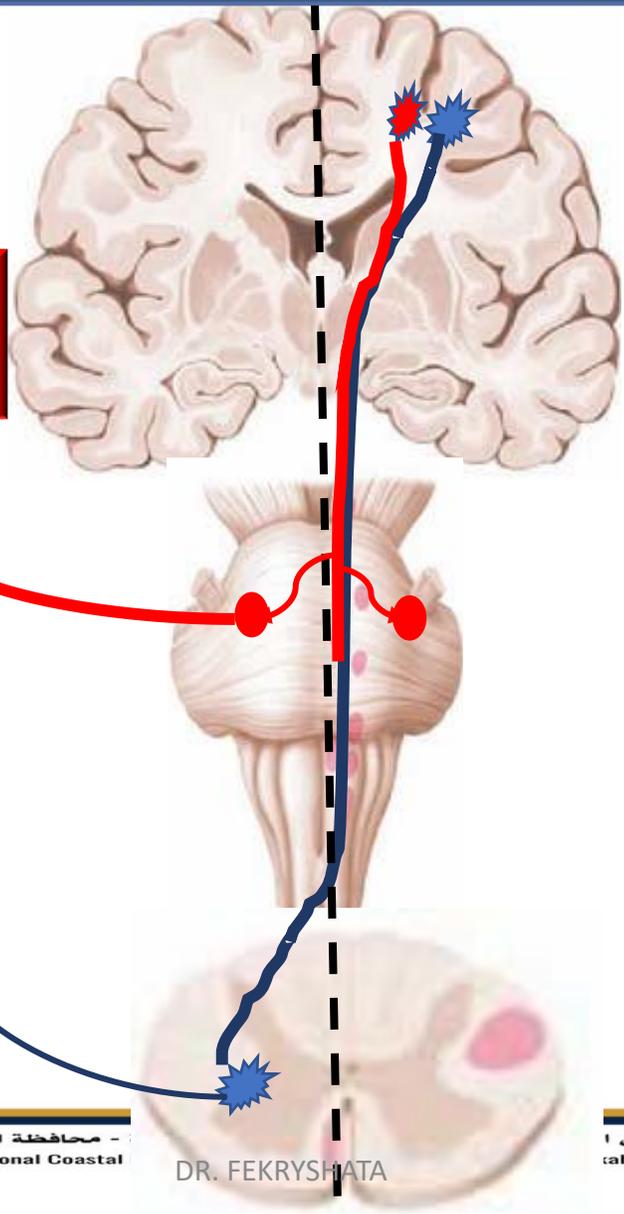


**LMN
Cranial nerves**

**LMN
Spinal nerves**

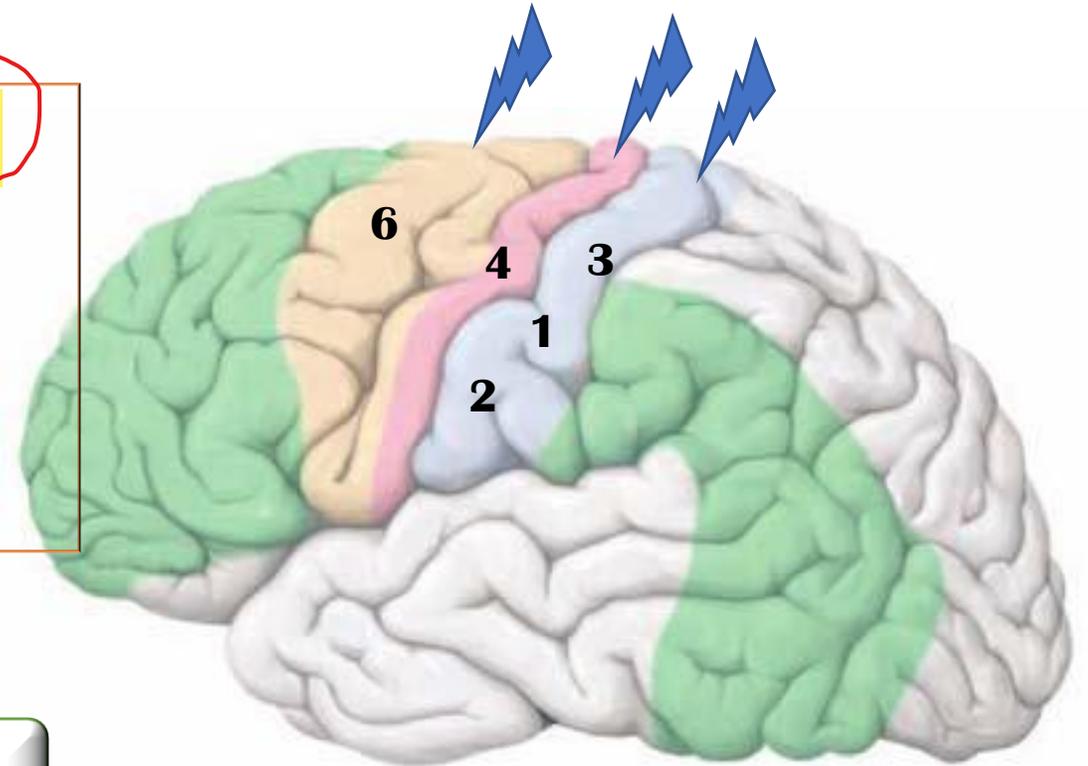
**UMN
Corticospinal**

**UMN
Corticobulbar**



Origin

- ❑ 40% of the fibers from upper two thirds of primary motor area 4
- ❑ 40% of the fibers from premotor area 6
- ❑ 20% of the fibers from general sensory area 3,1&2



Function:

- 1- Facilitation of the flexor muscle tone
- 2- Initiation of highly skilled fine movements
- 3- Modulate sensory input of the spinal cord

Course

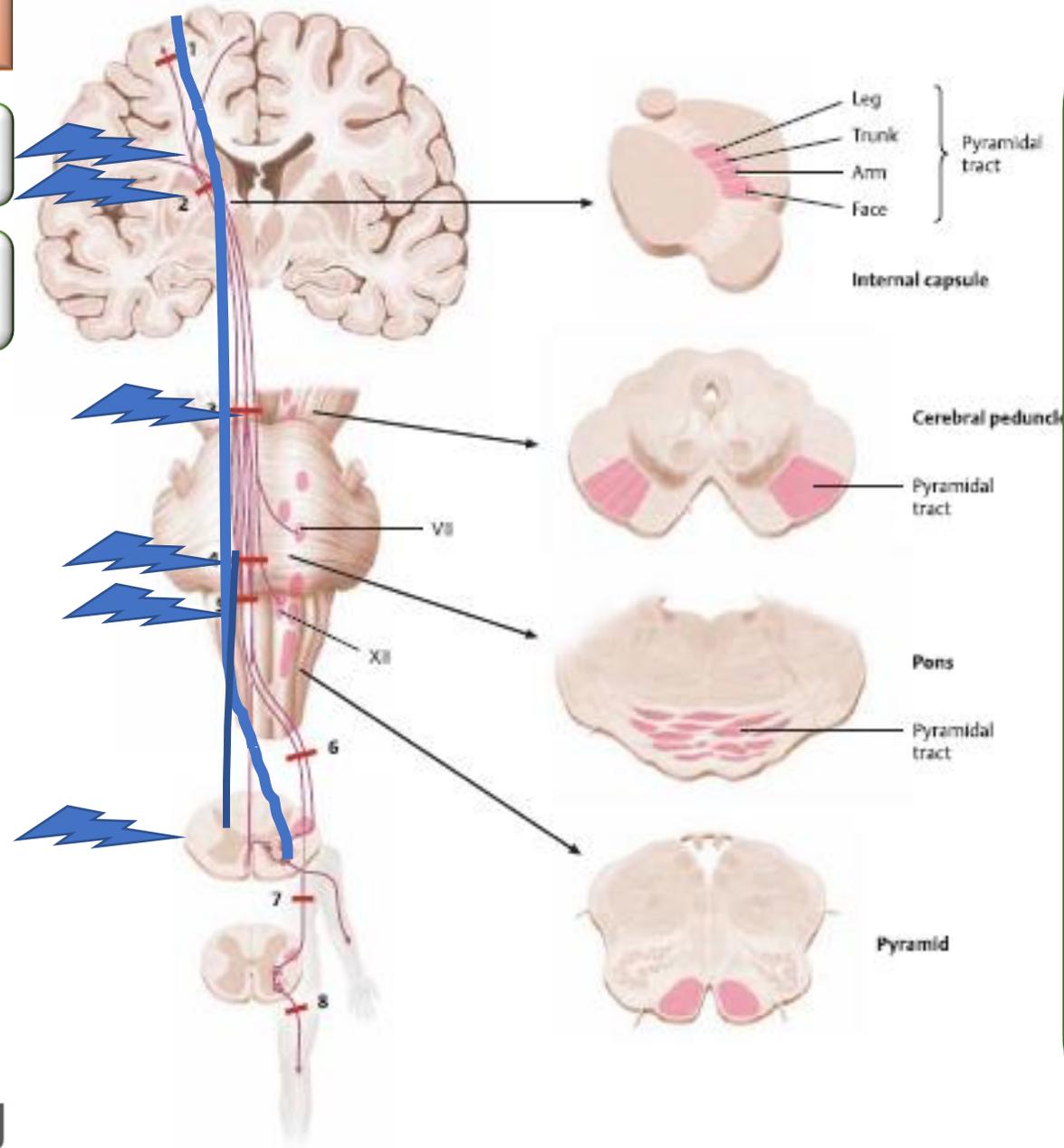
Corona radiata

Posterior limb of internal capsule

Crus cerebri

Basis pontis

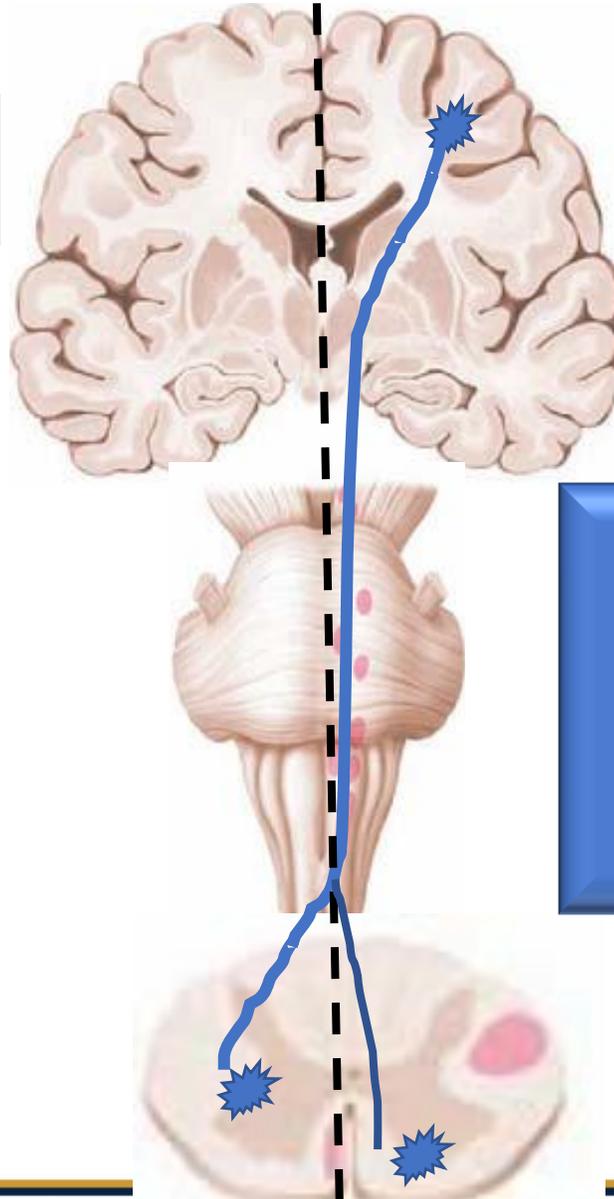
Pyramid



- 85% fibers cross to the opposite side and form lateral corticospinal tract.

- 15% fibers remain uncrossed and form ventral corticospinal tract

Corticospinal tract



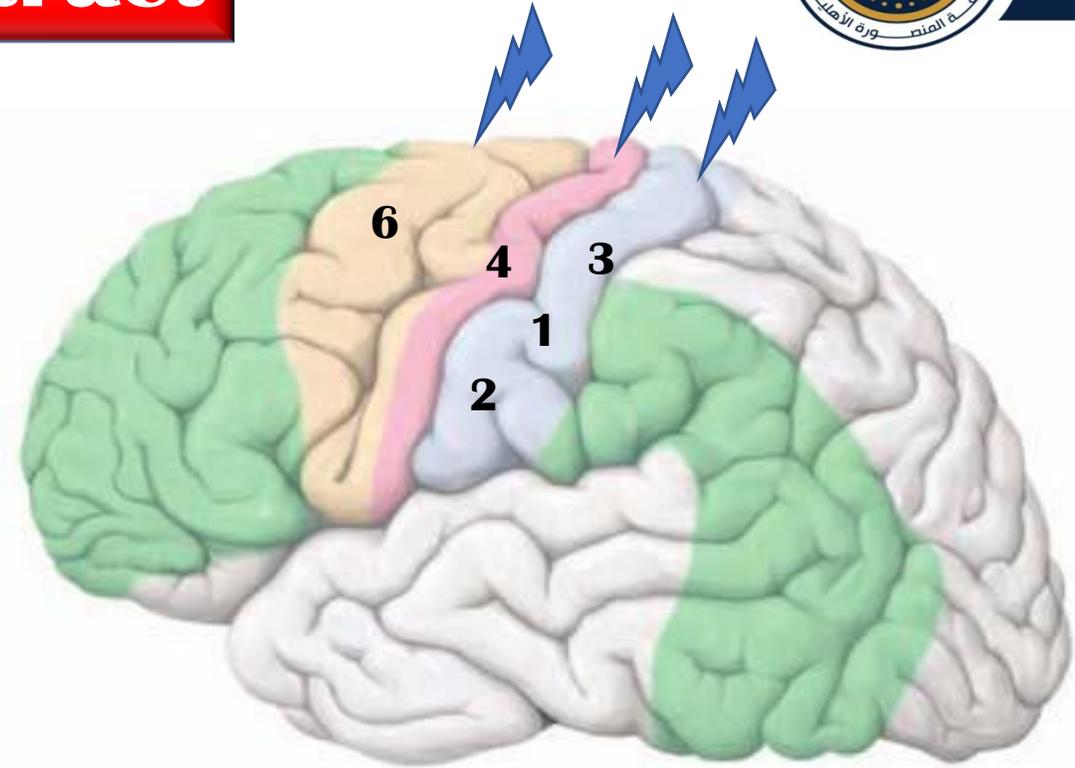
85% fibers cross to the opposite side and form **lateral corticospinal tract**.

15% fibers remain uncrossed and form **ventral corticospinal tract**

Corticobulbar tract

Origin

- ❑ **40%** of the fibers from lower third of primary motor area 4
- ❑ **40%** of the fibers from premotor area 6
- ❑ **20%** of the fibers from general sensory area 3,1&2



Course:

Corona radiata

Genu of internal capsule

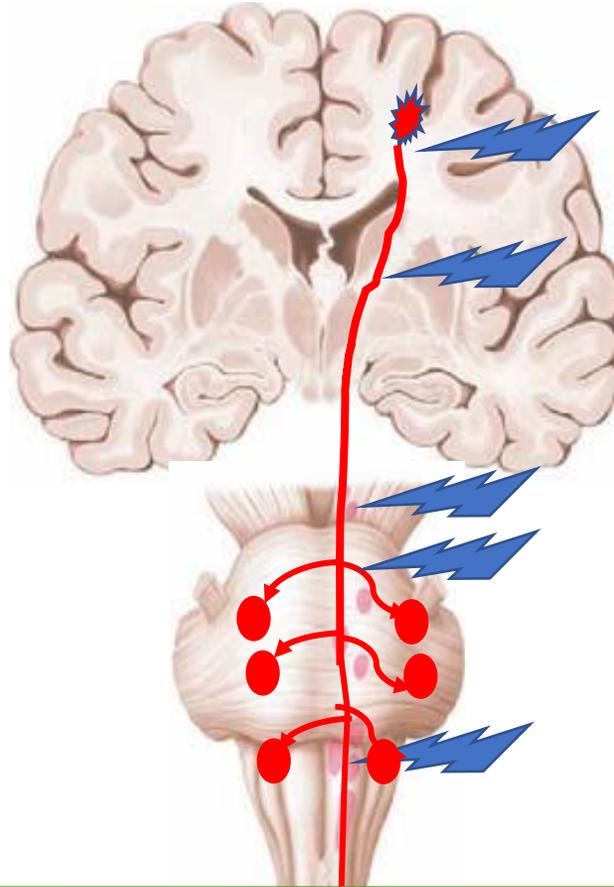
Crus cerebri

Basis pontis

Pyramid

Termination

- It terminates on the cranial nerve motor nuclei of the two sides.
- All cranial nerve motor nuclei receive bilateral corticobulbar fibers except the **lower part of facial nucleus** which receives fibers from opposite side only.





Descending Autonomic Fibers



Descending Autonomic Fibers

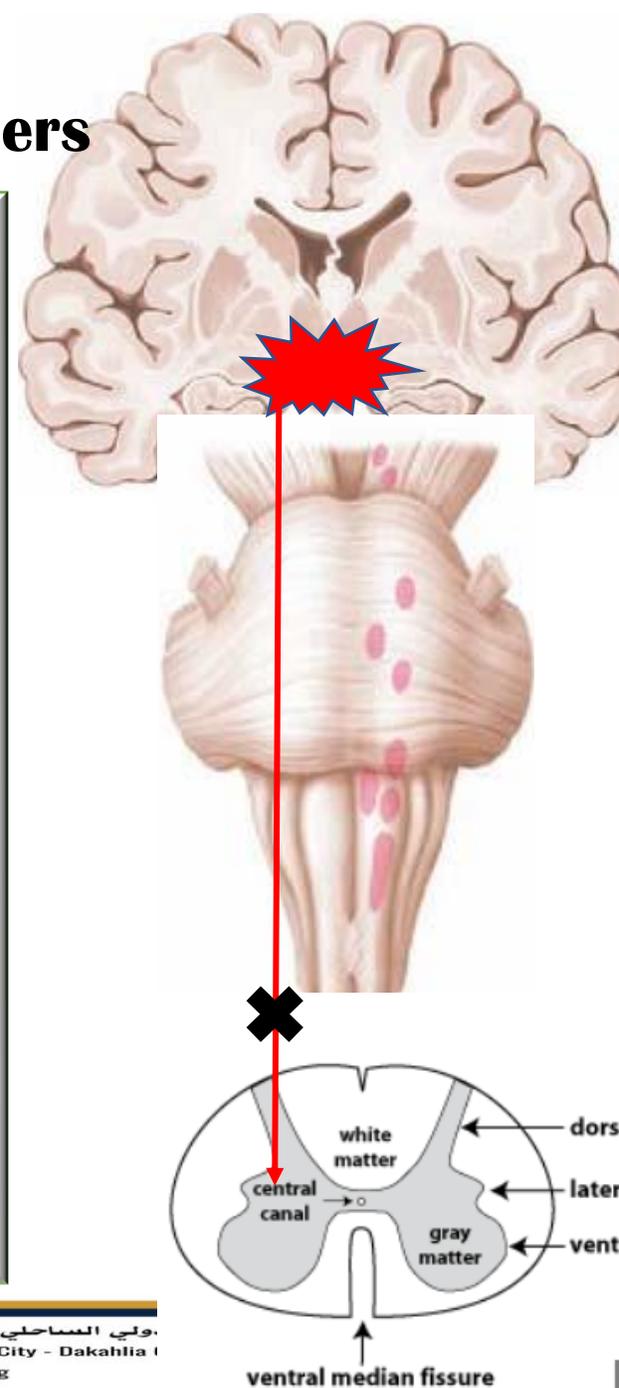
❑ **Origin:** from hypothalamus and autonomic centers in the reticular formation.

❑ **Termination:**

- Sympathetic nucleus in the lateral horn of spinal cord (T₁—L₃).
- Sacral parasympathetic nucleus (S₂—S₄).

❑ **Lesion:**

- Above T₁ will cause Horner's syndrome



Horner's syndrome



- ❑ **Ptosis:** paralysis of muller's muscle.
- ❑ **Miosis:** constriction of pupil.
- ❑ **Anhidrosis:** dry face due to paralysis of sweat glands.
- ❑ **Enophthalmos:** retraction of the eyeball.
- ❑ **Flushing:** warm and red face



Cranial Nerves

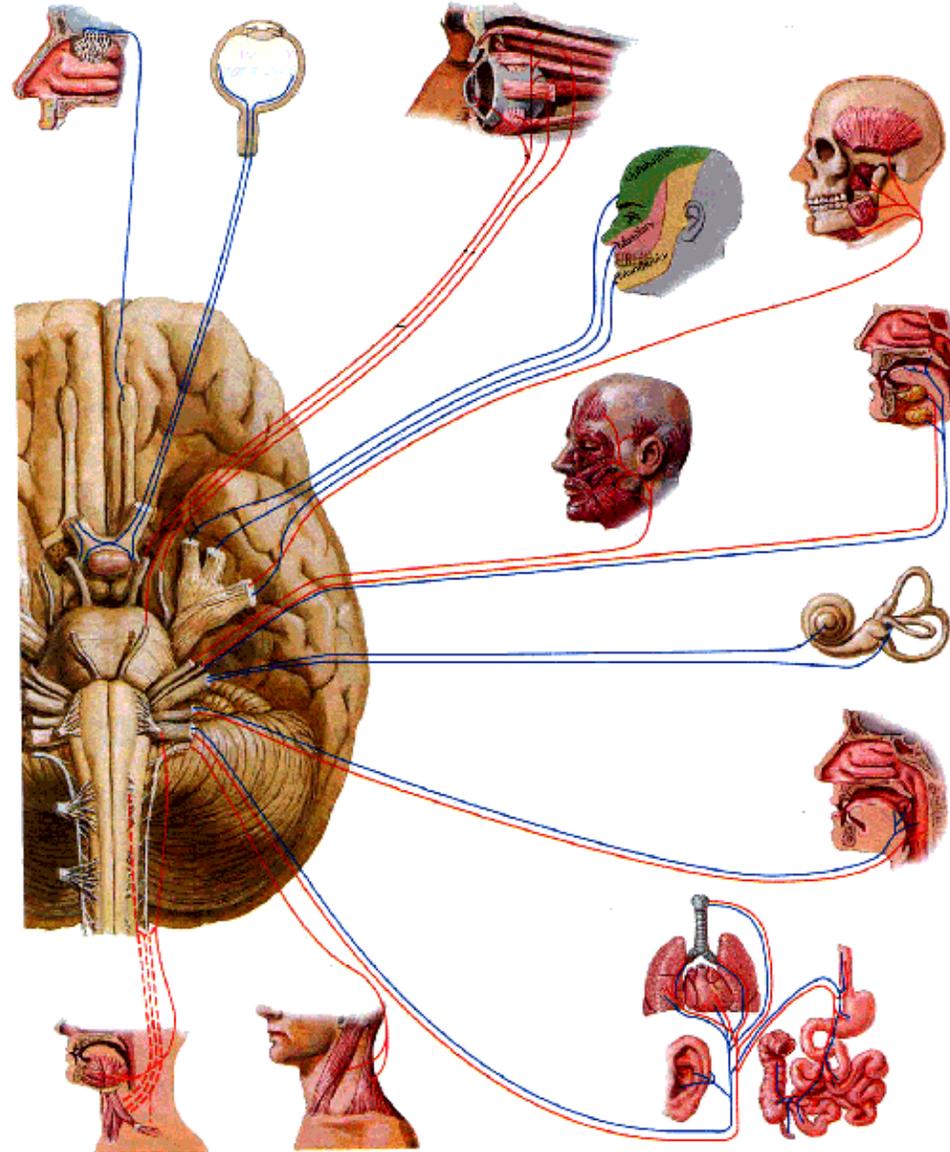
PART I

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M N U



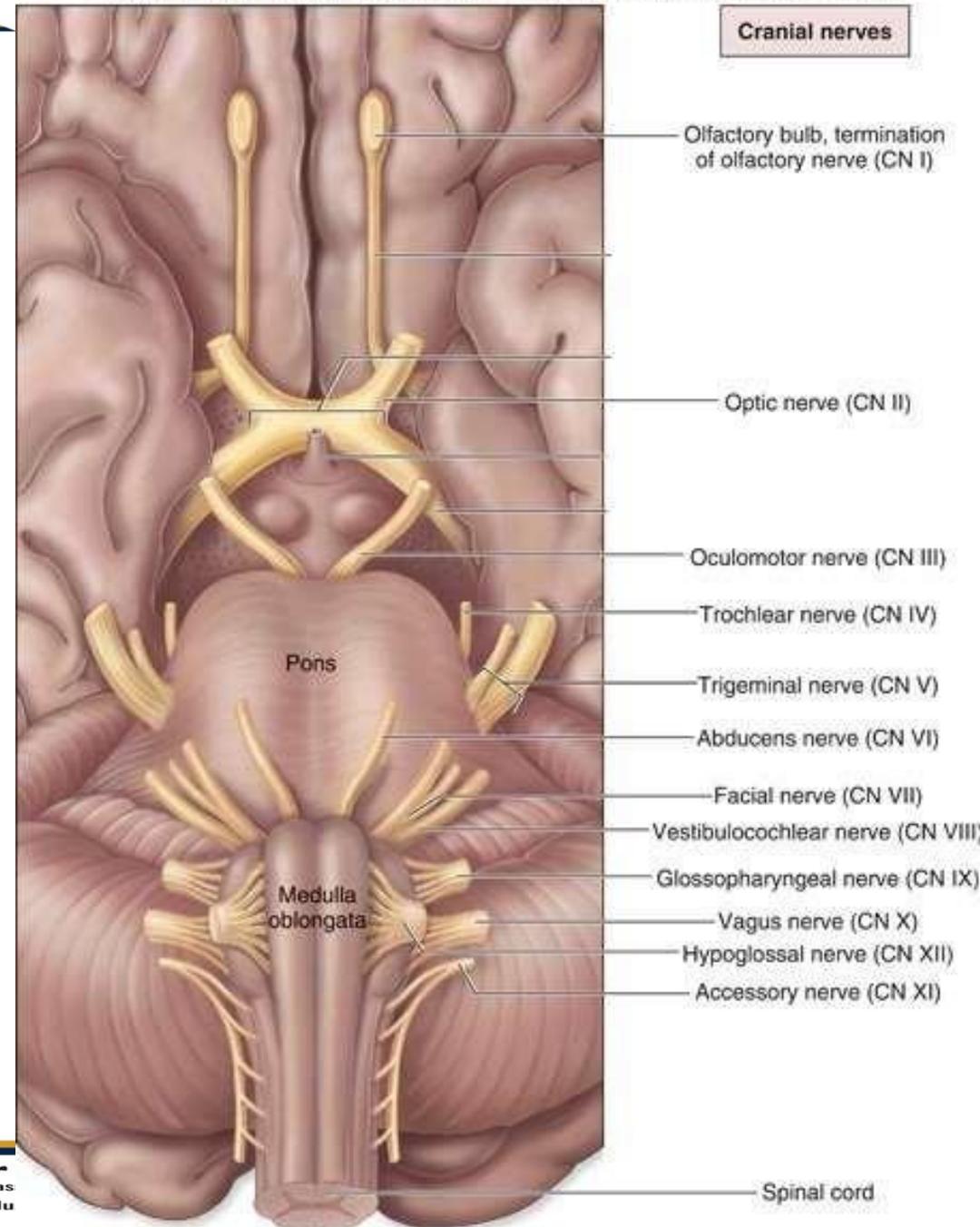
1. Olfactory nerve
2. Optic nerve
3. Oculomotor nerve
4. Trochlear nerve
5. Trigeminal nerve
6. Abducent nerve
7. Facial nerve
8. Vestibulocochlear nerve
9. Glossopharyngeal nerve
10. Vagus nerve
11. Accessory nerve
12. Hypoglossal nerve



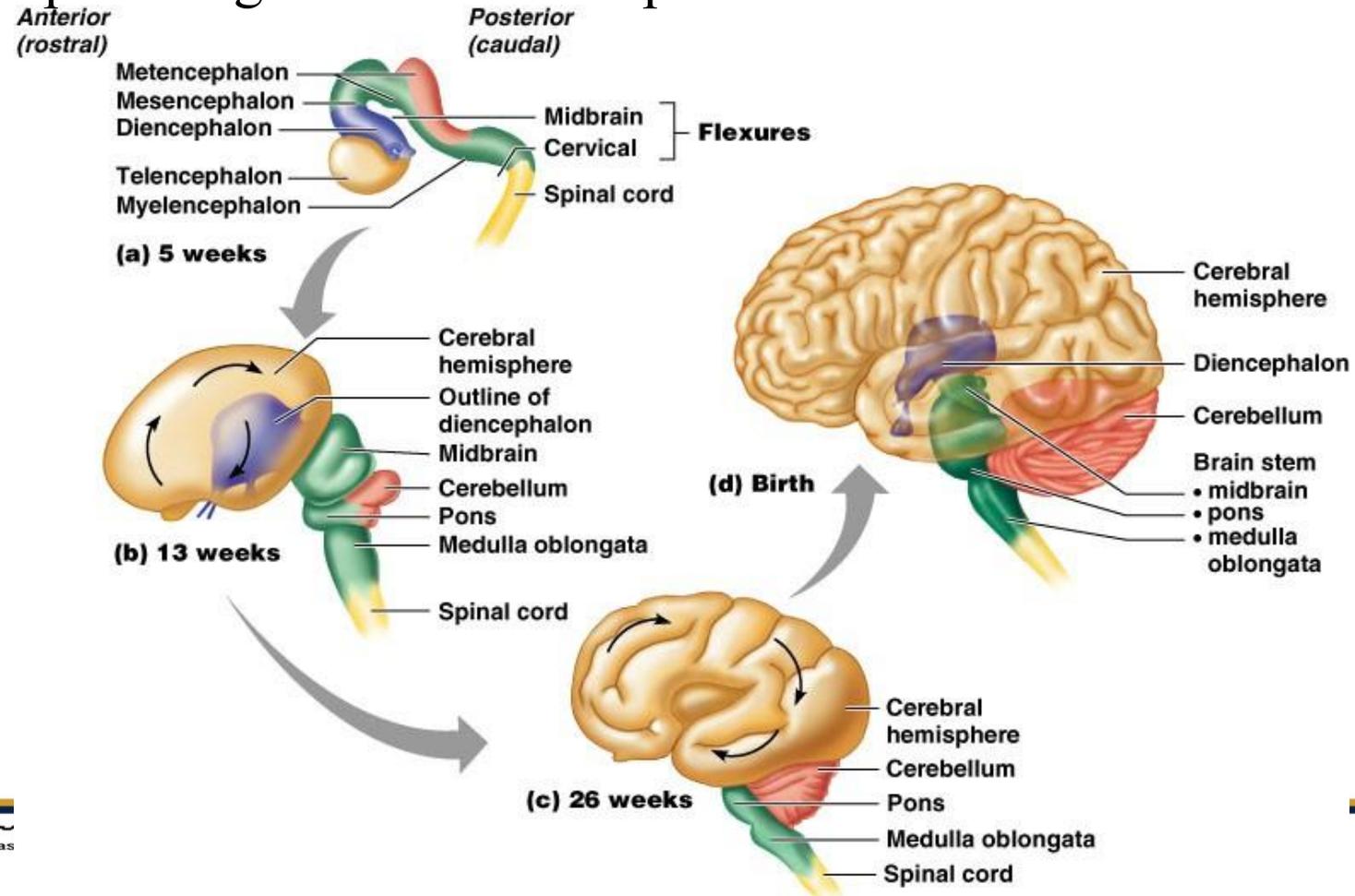
Cranial nerves

Origin of the Cranial Nerves

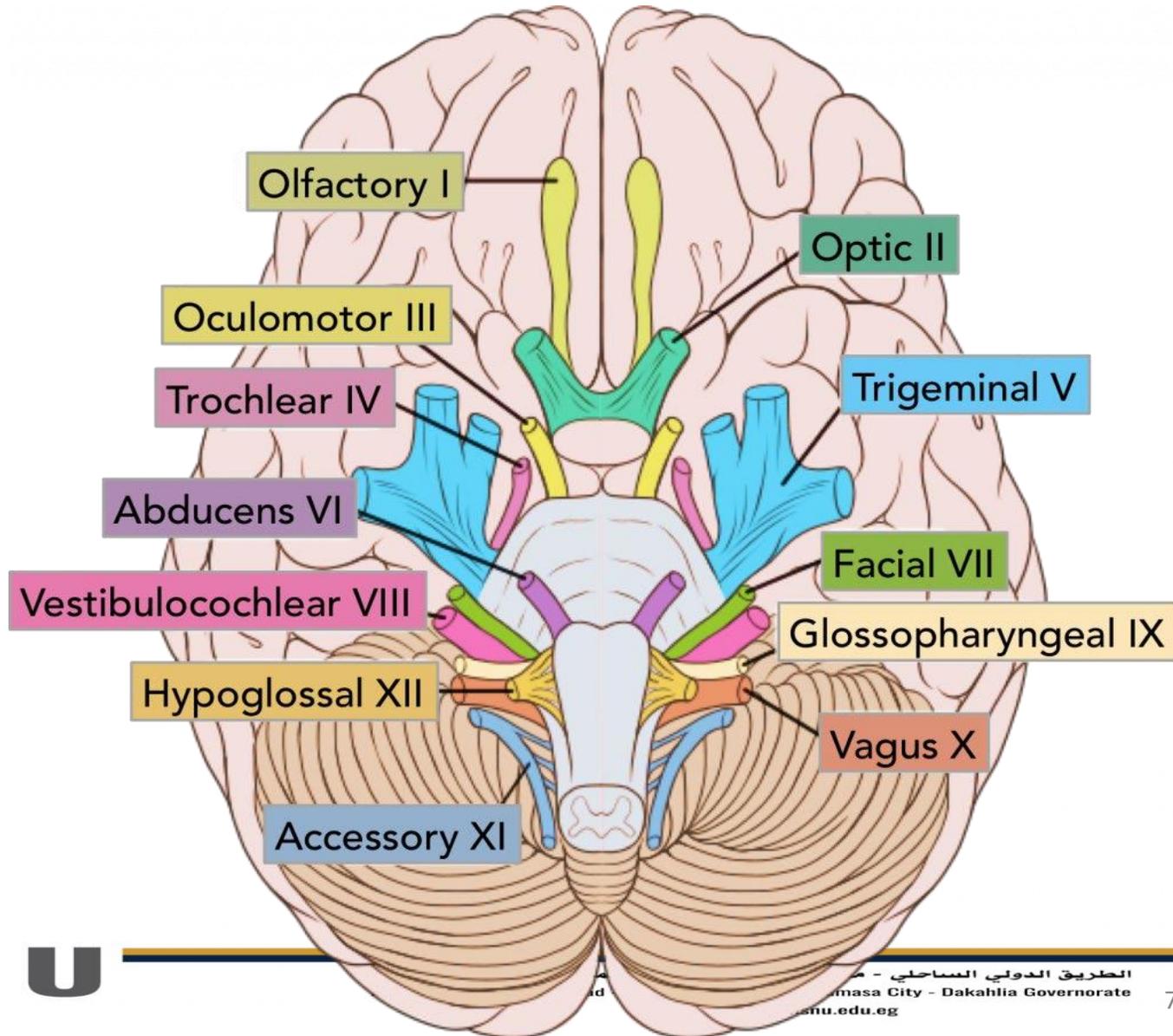
- There are twelve cranial nerves in total.
- The olfactory nerve (CN I) and optic nerve (CN II) originate from the **cerebrum**.
- Cranial nerves III – XII arise from the ventral surface of **brain stem**.
- **Except**, the trochlear nerve (IV) comes from the posterior side of the midbrain.

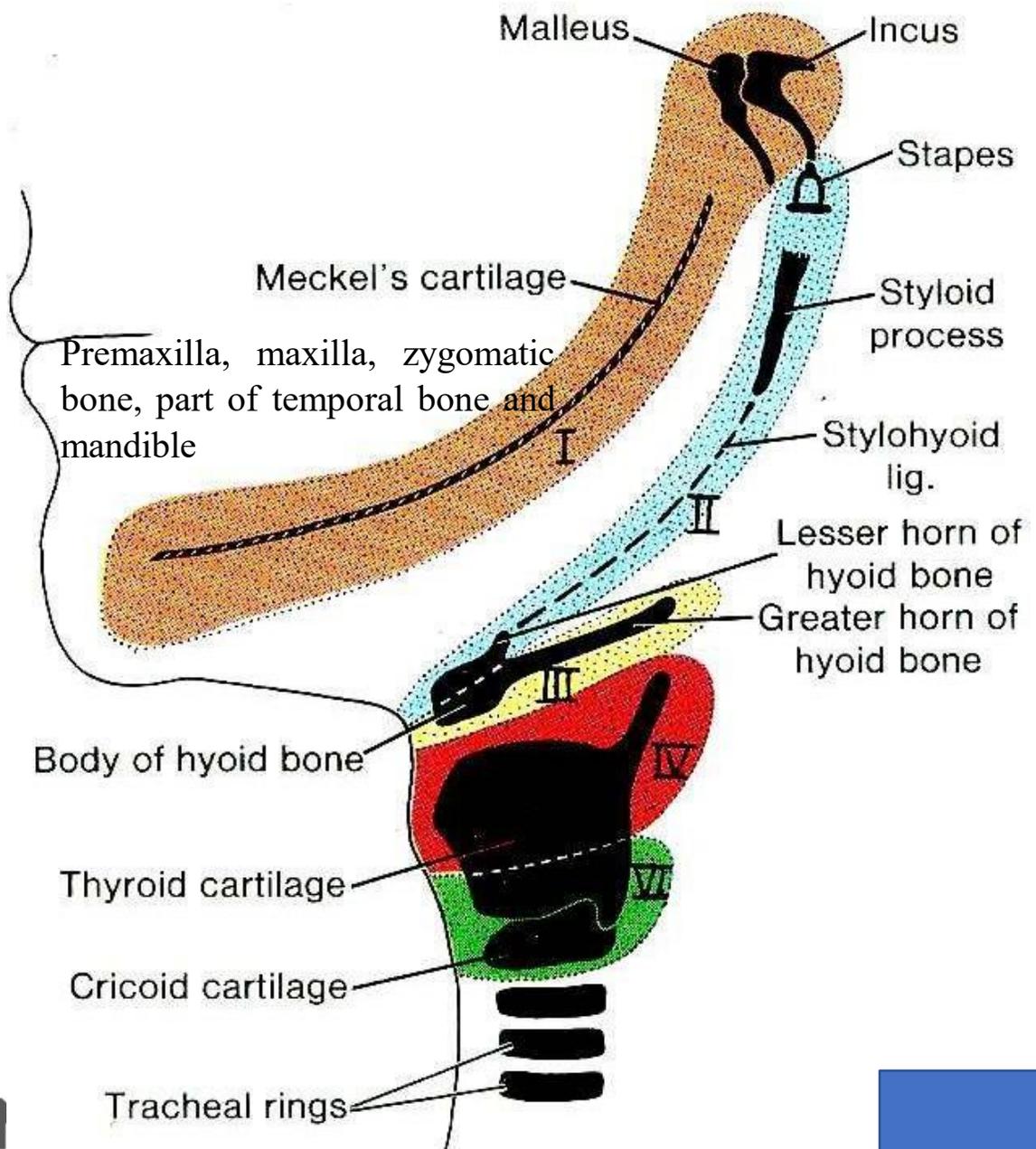


- **Olfactory nerve (I):** is developing as an early part of the primitive telencephalon
- **Optic nerve (II):** is developing as an outpouching from the diencephalon
- **Cranial nerves III to XII:**
 - ❖ Originate from the **brain stem**



Cranial nerves and the brain





Mandibular branch of trigeminal nerve (V)

Facial nerve (VII)

Pharyngeal and laryngeal muscles (Nucleus ambiguus via IX, X, XI nerves)

Glossopharyngeal nerve (IX)

Superior laryngeal branch of vagus nerve (X)

Recurrent laryngeal branch of vagus nerve (X)

2

3

4

&

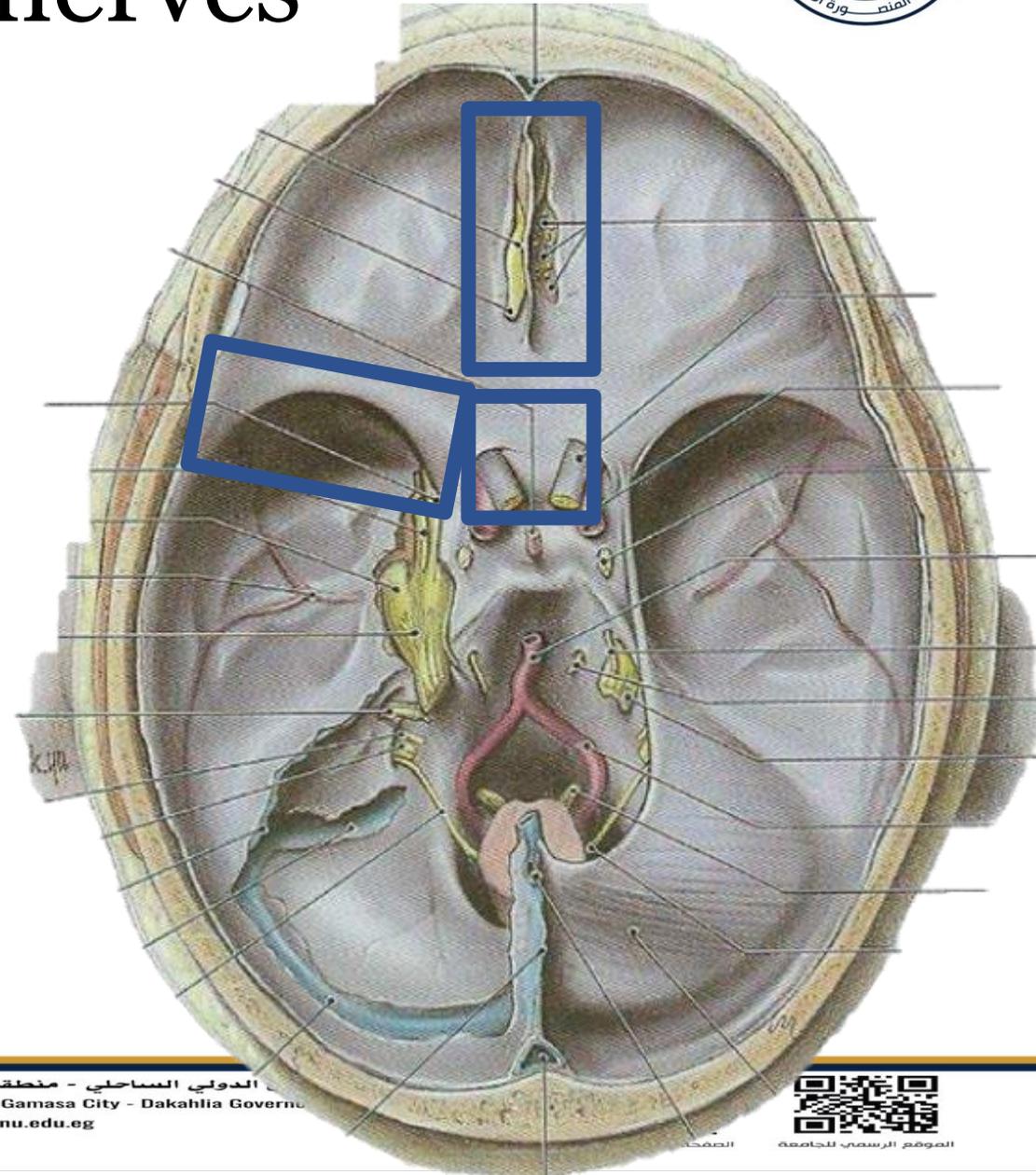
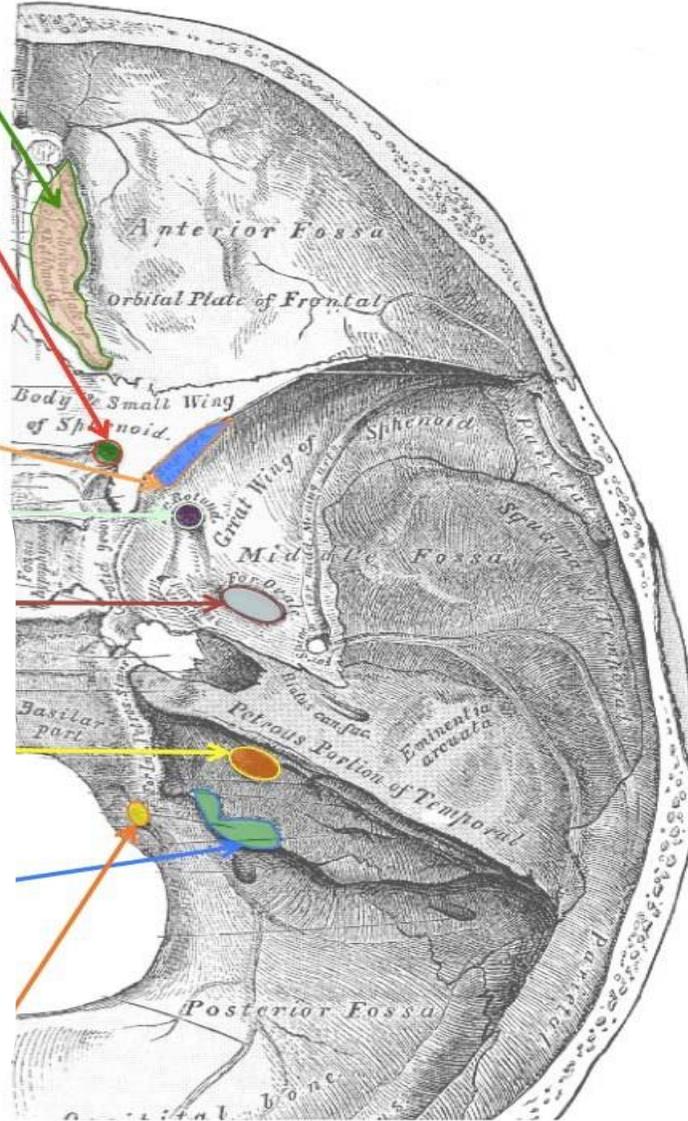
6

Exit of Cranial nerves

Cribriform plate
Olfactory n (CNI)

Optic canal
Optic n (CNII)

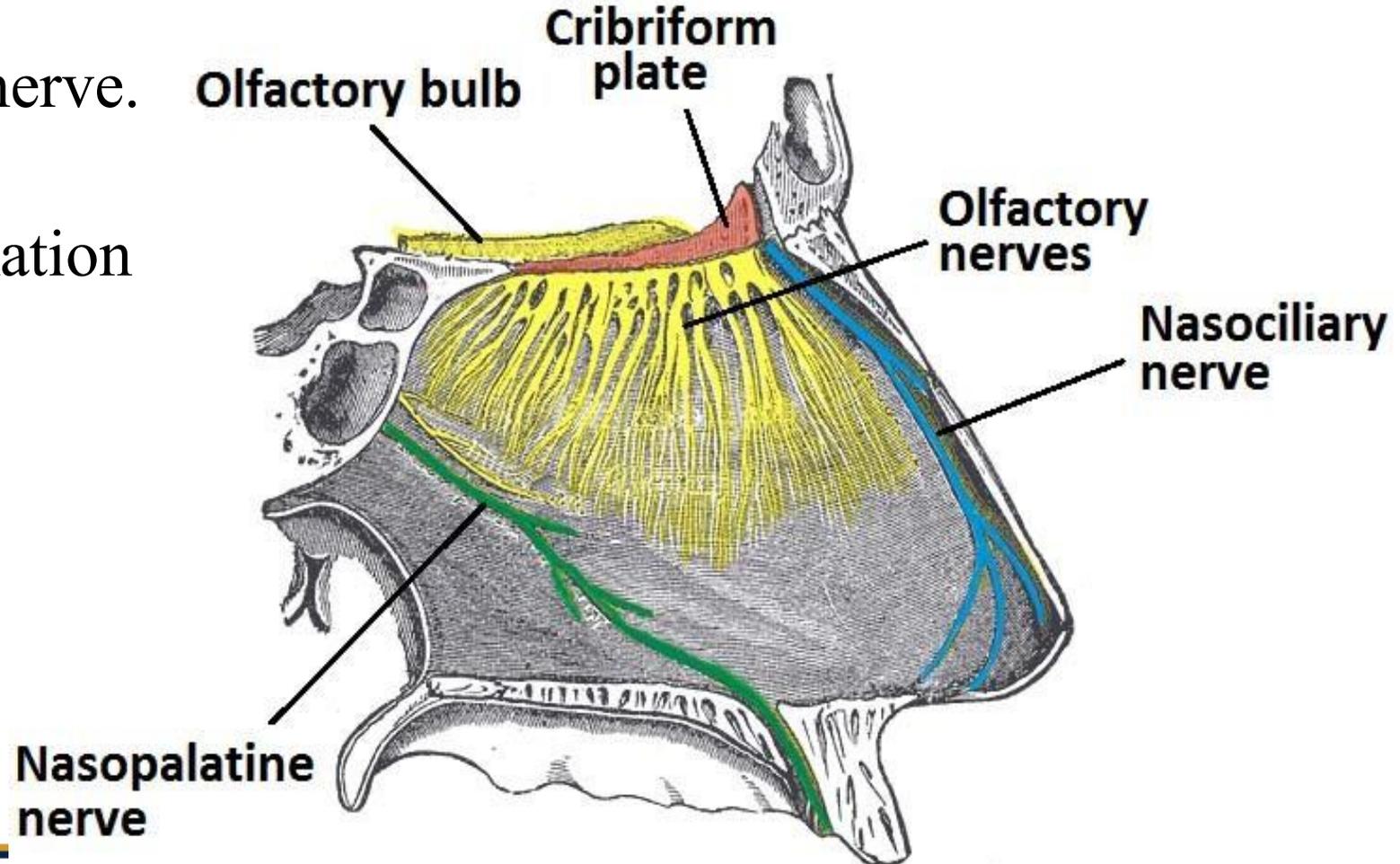
Superior orbital fissure
Oculomotor n (CNIII)
Trochlear n (CNIV)
Ophthalmic n (CNV₁)
Abducens n (CNVI)



Cranial nerves – CN I

The olfactory nerve (CN I)

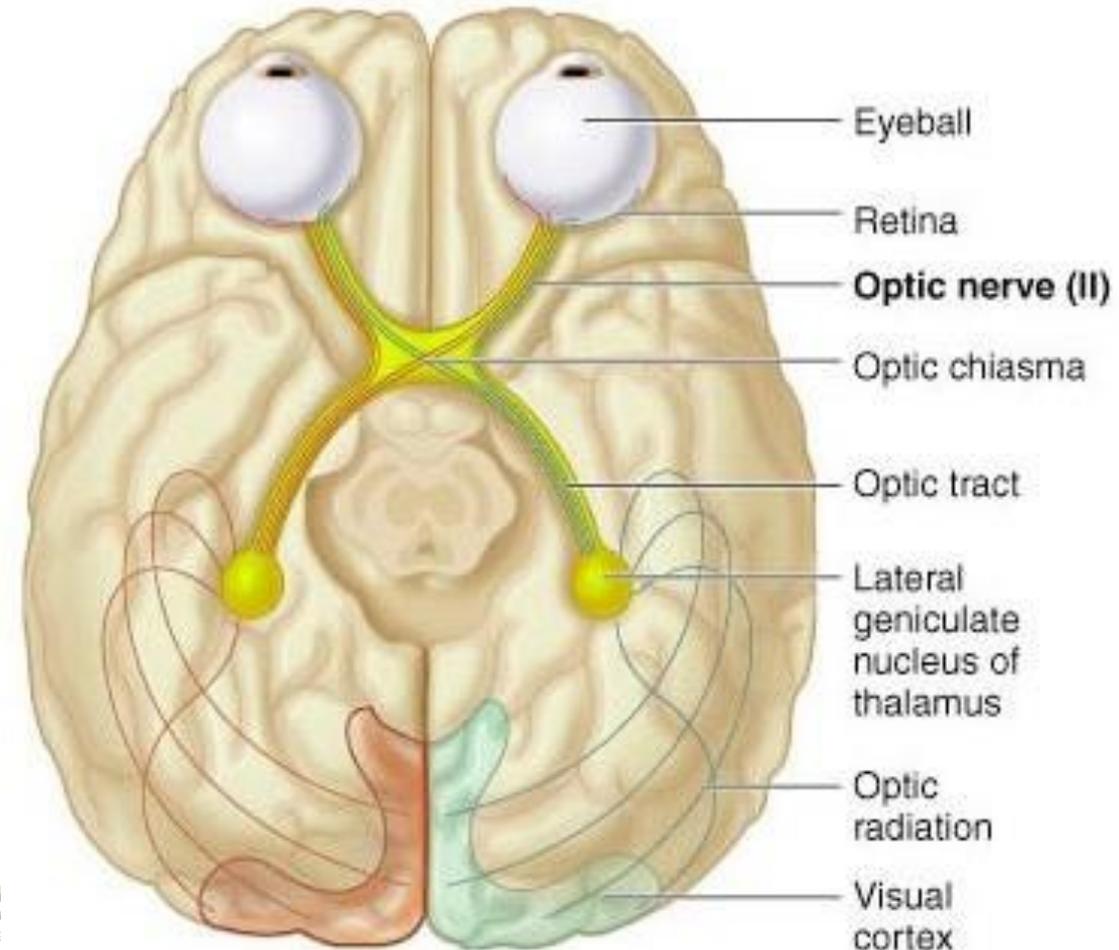
- The first and shortest cranial nerve.
- It is a special visceral afferent nerve, which transmits information related to **smell**.



Cranial nerves – CN II

The optic nerve (CN II)

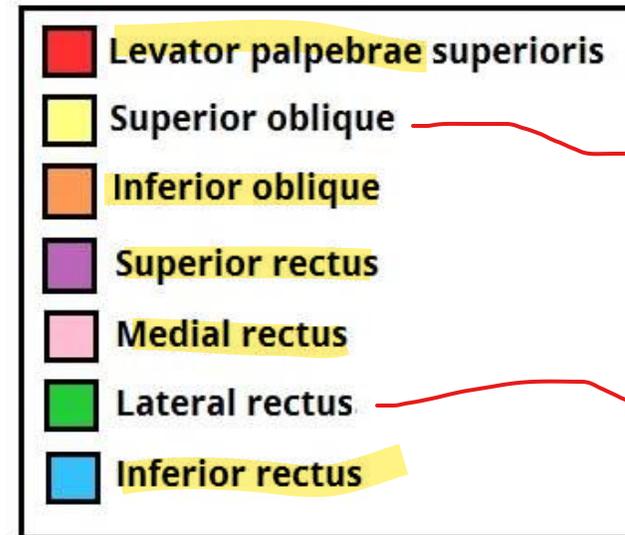
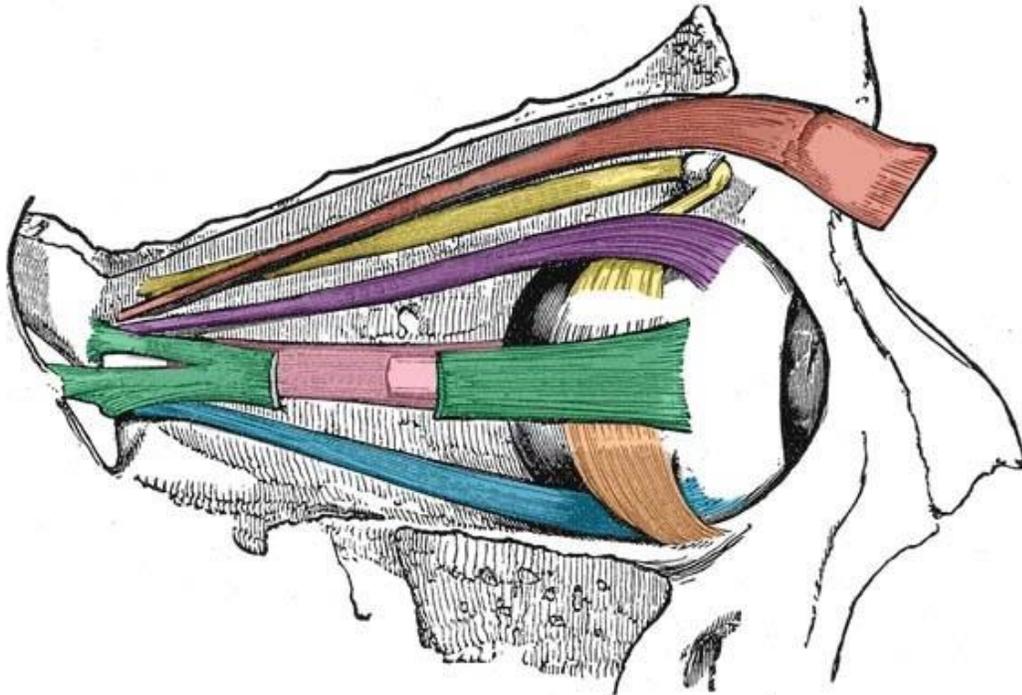
- It is responsible for transmitting the special sensory information for **vision**.
- The optic nerve is considered a part of the central nervous system and examination of the nerve enables an assessment of intracranial health.



Cranial nerves – CN III

The oculomotor nerve (CN III)

- The third cranial nerve (CN III). It provides motor and parasympathetic innervation to some of the structures within the bony orbit.



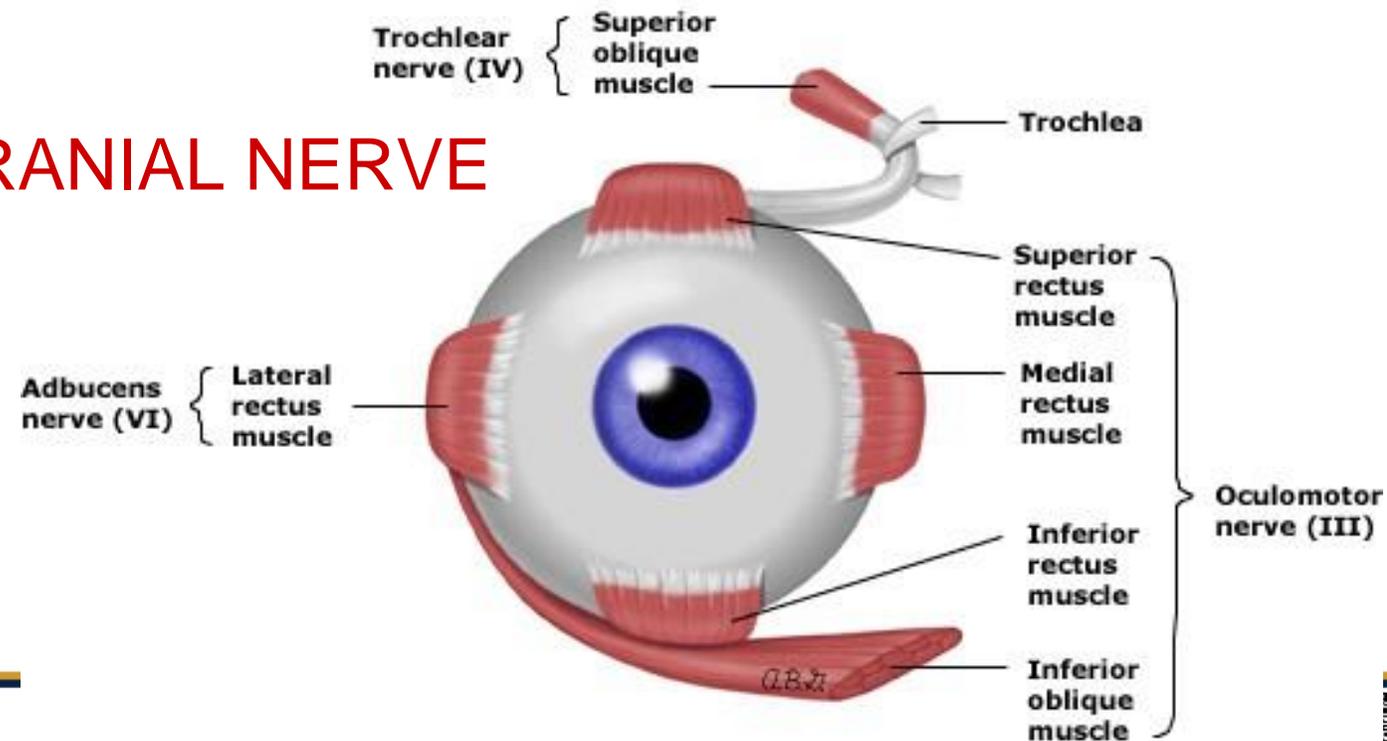
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6

Cranial nerves – CN III

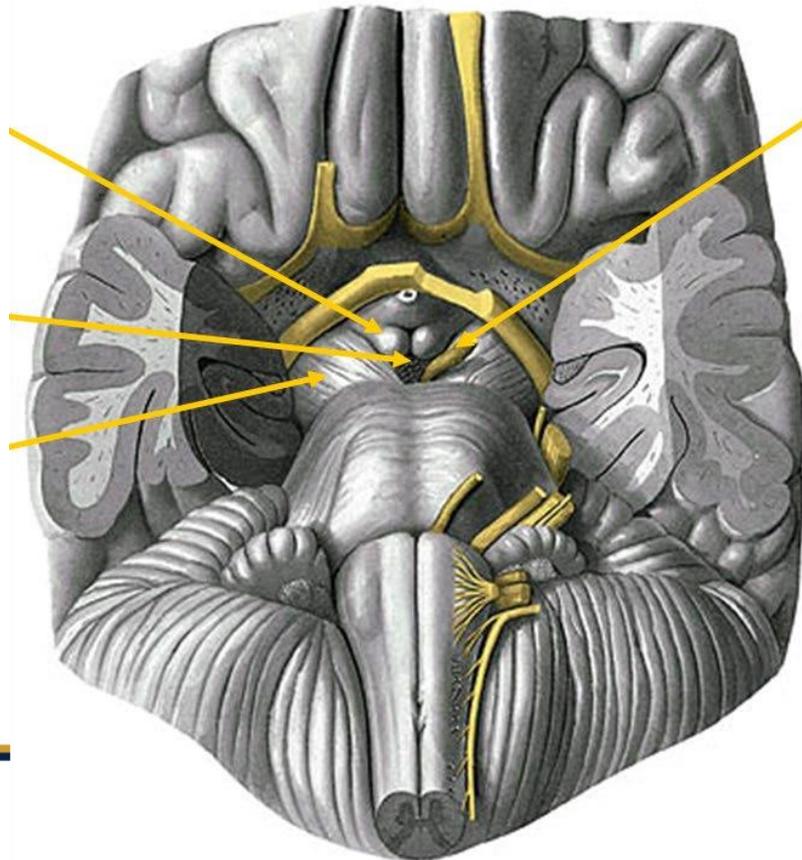
- **Motor** – Innervates the majority of the **extraocular muscles** (levator palpebrae superioris, superior rectus, inferior rectus, medial rectus and inferior oblique).
- **Parasympathetic** – Supplies the sphincter pupillae and the ciliary muscles of the eye.

NUCLEI OF ANY CRANIAL NERVE

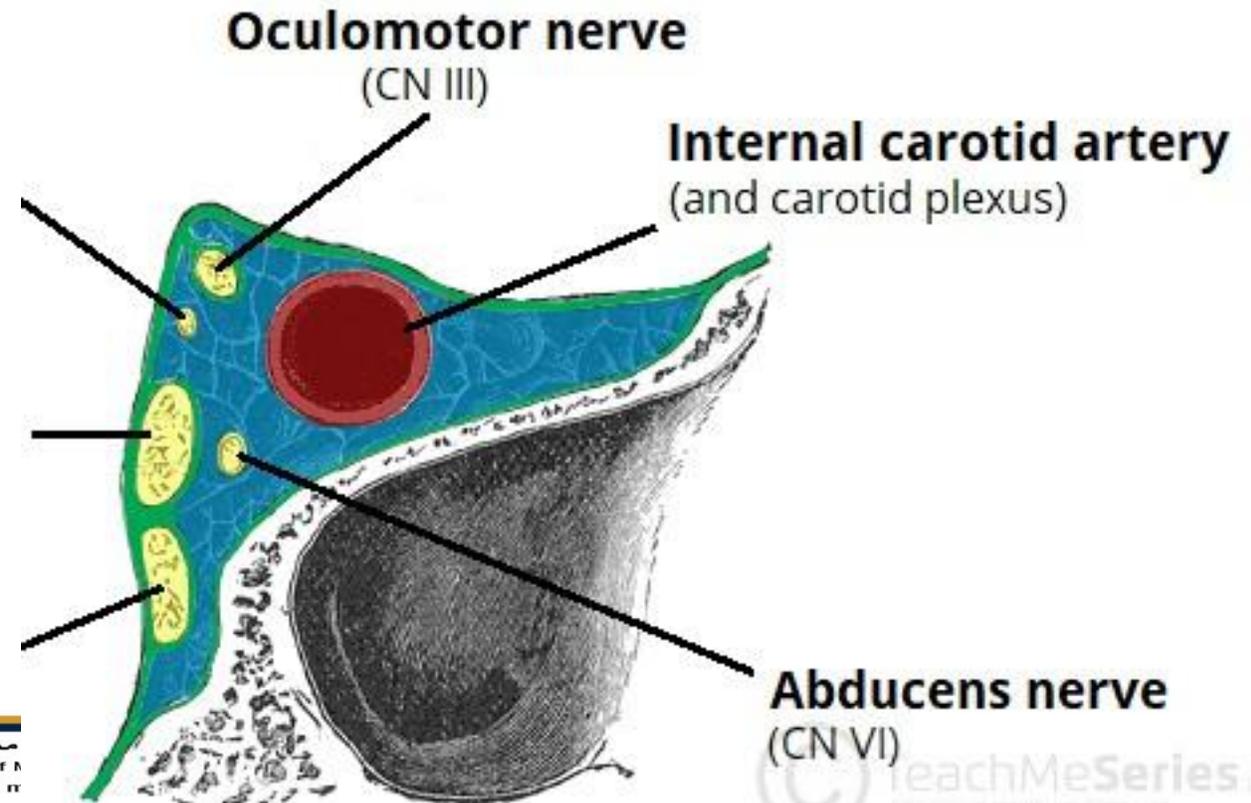


Cranial nerves – CN III

- The **oculomotor nerve** originates from the oculomotor nucleus – located within the midbrain.
- The nerve then pierces the dura mater and enters the lateral wall of the **cavernous sinus**.

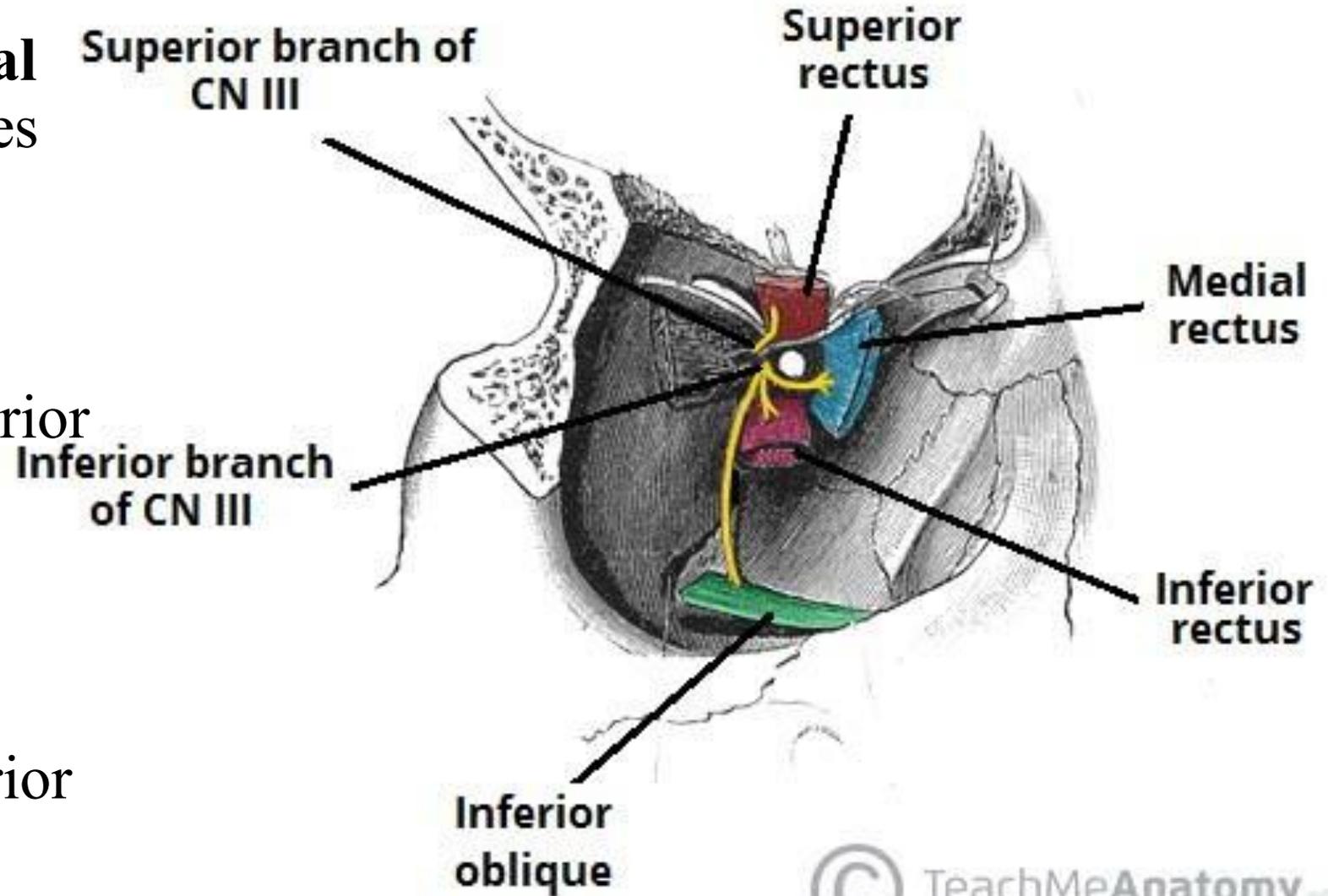


oculomotory
nerve (III)



Cranial nerves – CN III

- The nerve leaves the cranial cavity via the **superior orbital fissure**. At this point, it divides into superior and inferior branches:
- **Superior branch** – provides motor innervation to the superior rectus and levator palpebrae superioris.
- **Inferior branch** – provides motor innervation to the inferior rectus, medial rectus and inferior oblique.

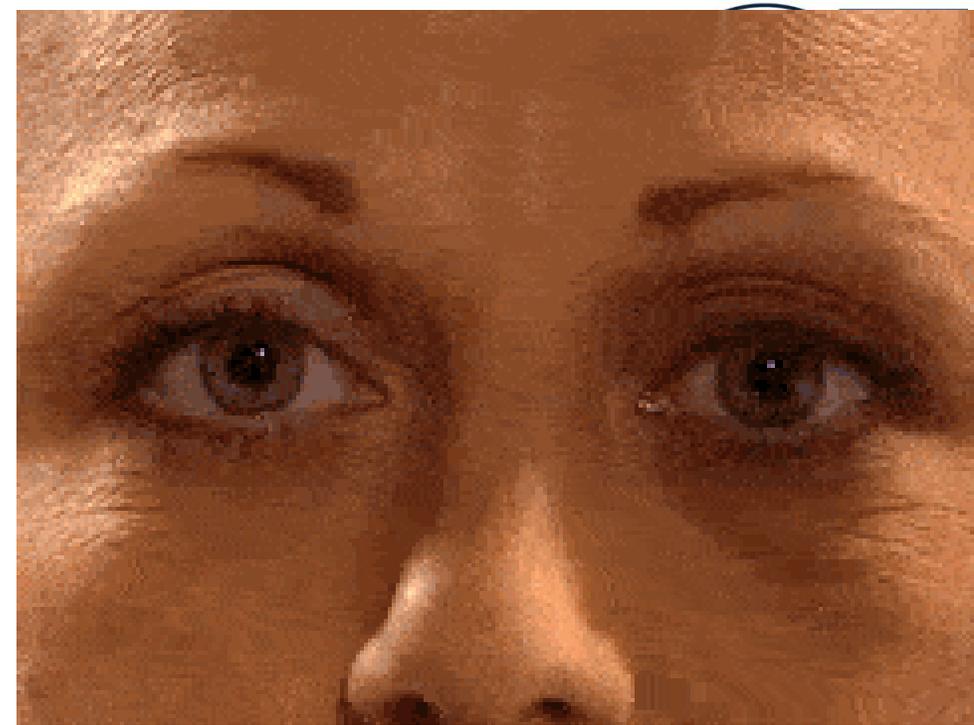


Cranial nerves – CN III

Parasympathetic Functions

There are two structures in the eye that receive parasympathetic innervation from the oculomotor nerve:

- **Sphincter pupillae** – constricts the pupil, reducing the amount of light entering the eye.
- **Ciliary muscles** – contracts, causes the lens to become more spherical, and thus more adapted to short range vision. [Accommodation]

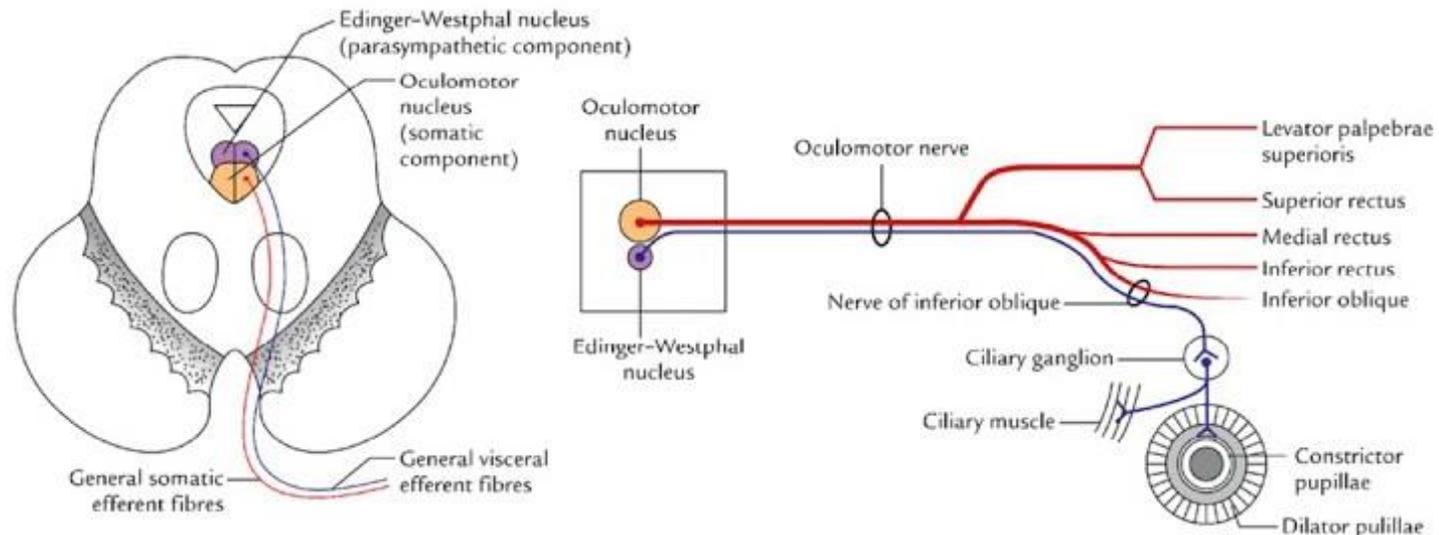


Cranial nerves – CN III

Parasympathetic Functions

- The pre-ganglionic parasympathetic fibers travel in the inferior branch of the oculomotor nerve. Within the orbit, they branch off and synapse in the **ciliary ganglion**. The post-ganglionic fibers are carried to the eye via the short ciliary nerves.

Oculomotor Nerve (CN III) - Pupillary Constriction



Functional components and nuclei

Distribution of the constitutional fibres

Oculomotor paralysis

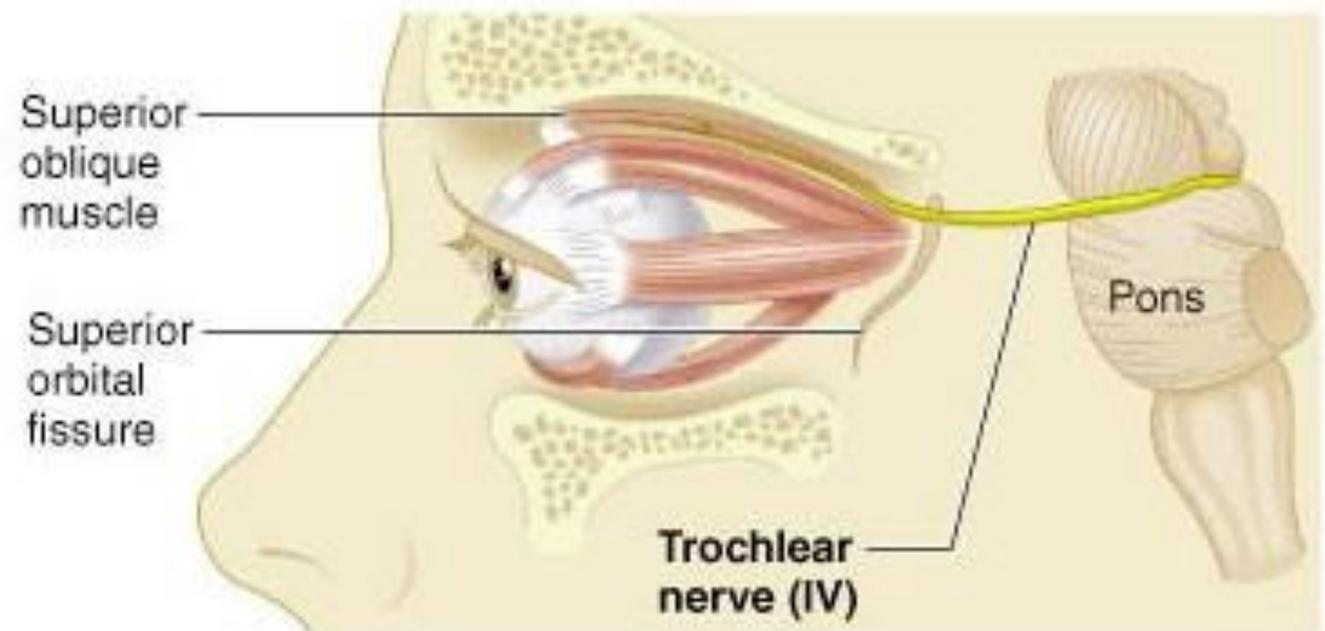
SQUINT
PTOSIS



Cranial nerves – CN IV

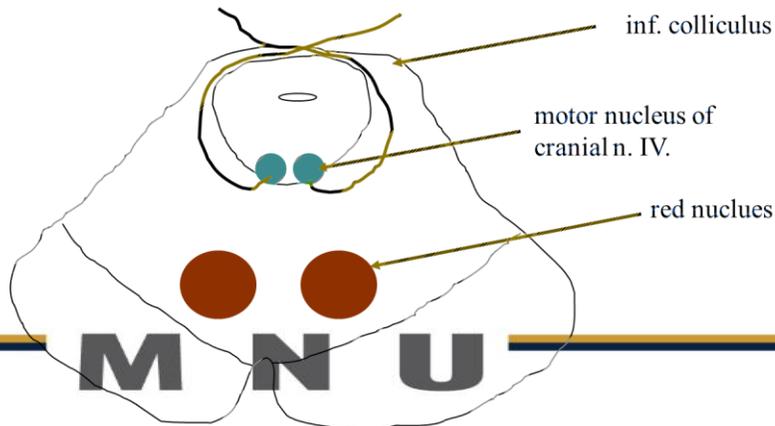
The trochlear nerve (CN IV)

- The fourth cranial nerve.
- It has the longest intracranial course.
- It has a purely somatic motor function.



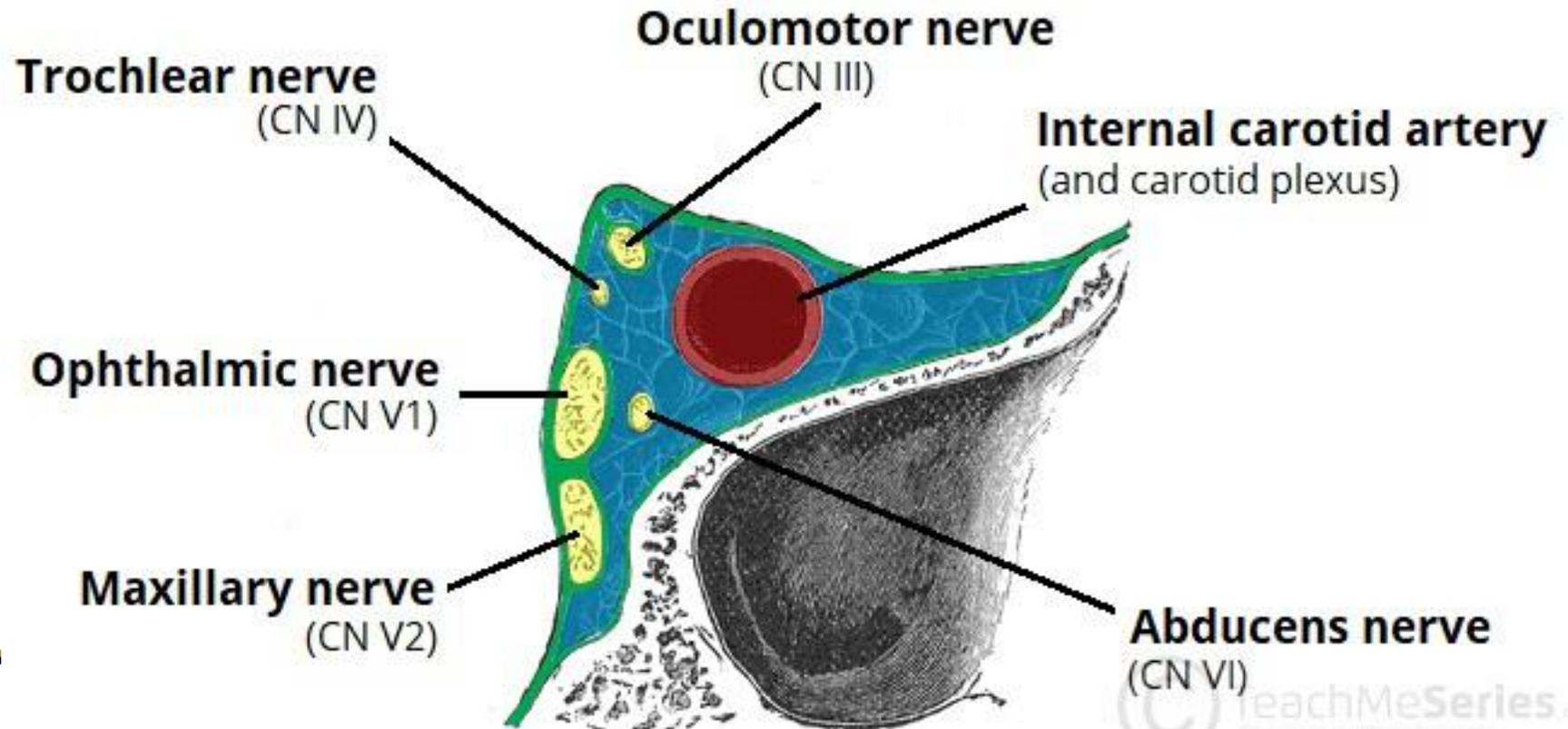
Cranial nerves – CN IV

- The trochlear nerve arises from the **trochlear nucleus** of the brain, emerging from the posterior aspect of the midbrain
- It is the only cranial nerve to **exit from the posterior midbrain.**



Cranial nerves – CN IV

- The trochlear nerve then moves along the lateral wall of the **cavernous sinus** before entering the orbit of the eye via the **superior orbital fissure**.



Cranial nerves – CN IV

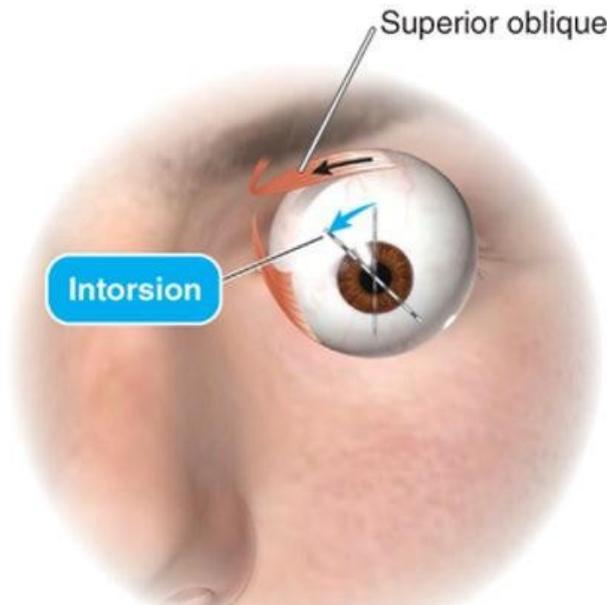
Motor Function

- The trochlear nerve innervates the **contralateral** superior oblique.

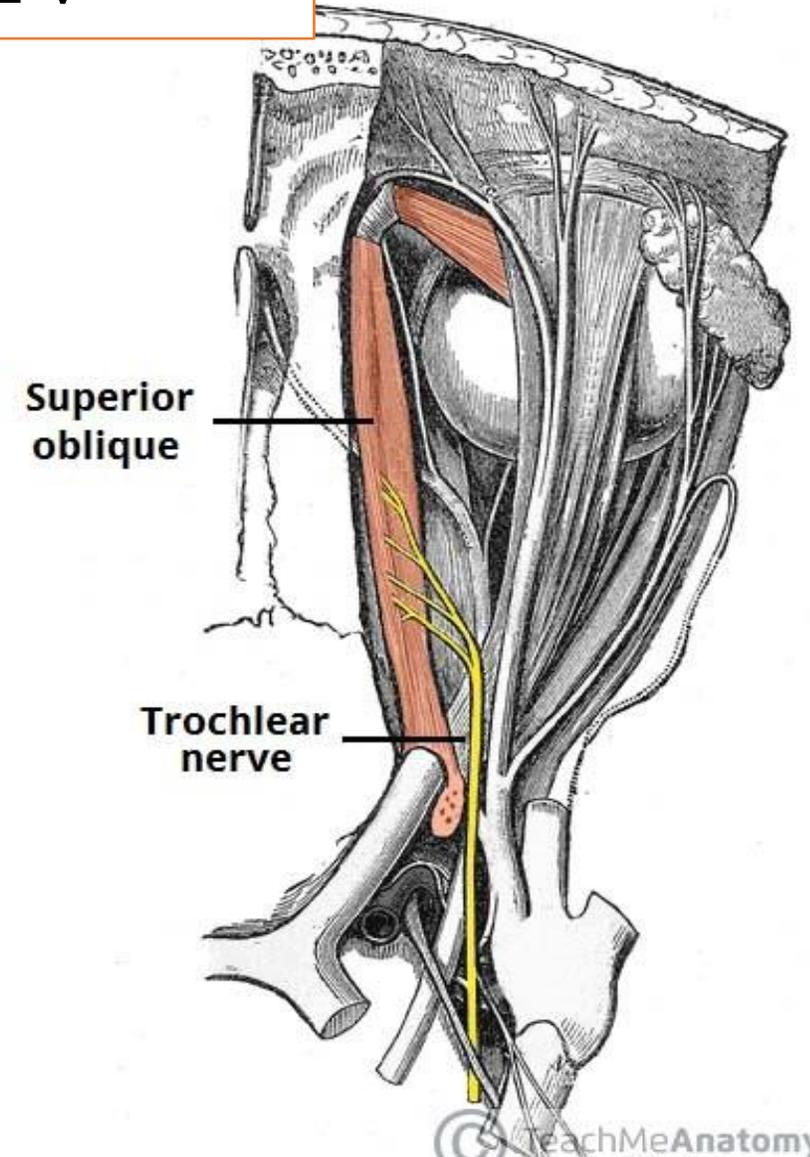
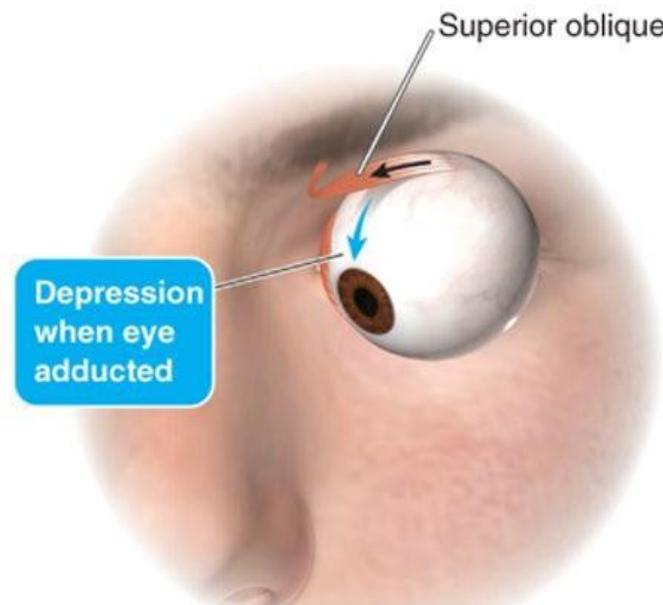
SO4

- The action of the **superior oblique** is to depress and intort the eyeball.

A



B



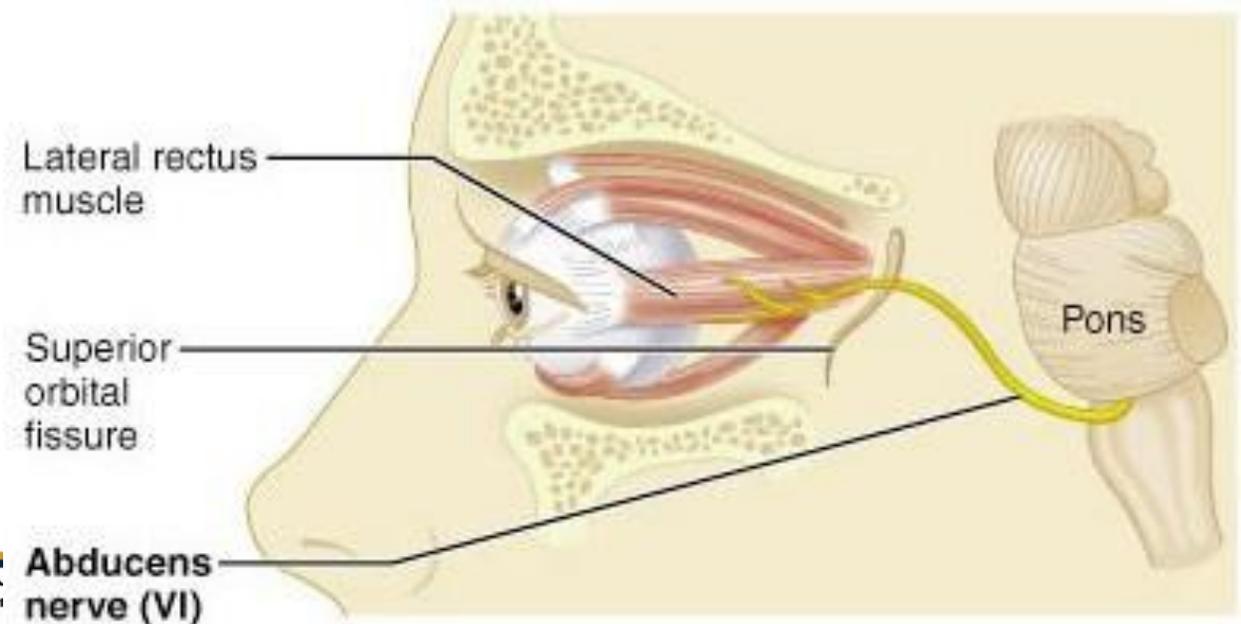
LESION



Cranial nerves – CN VI

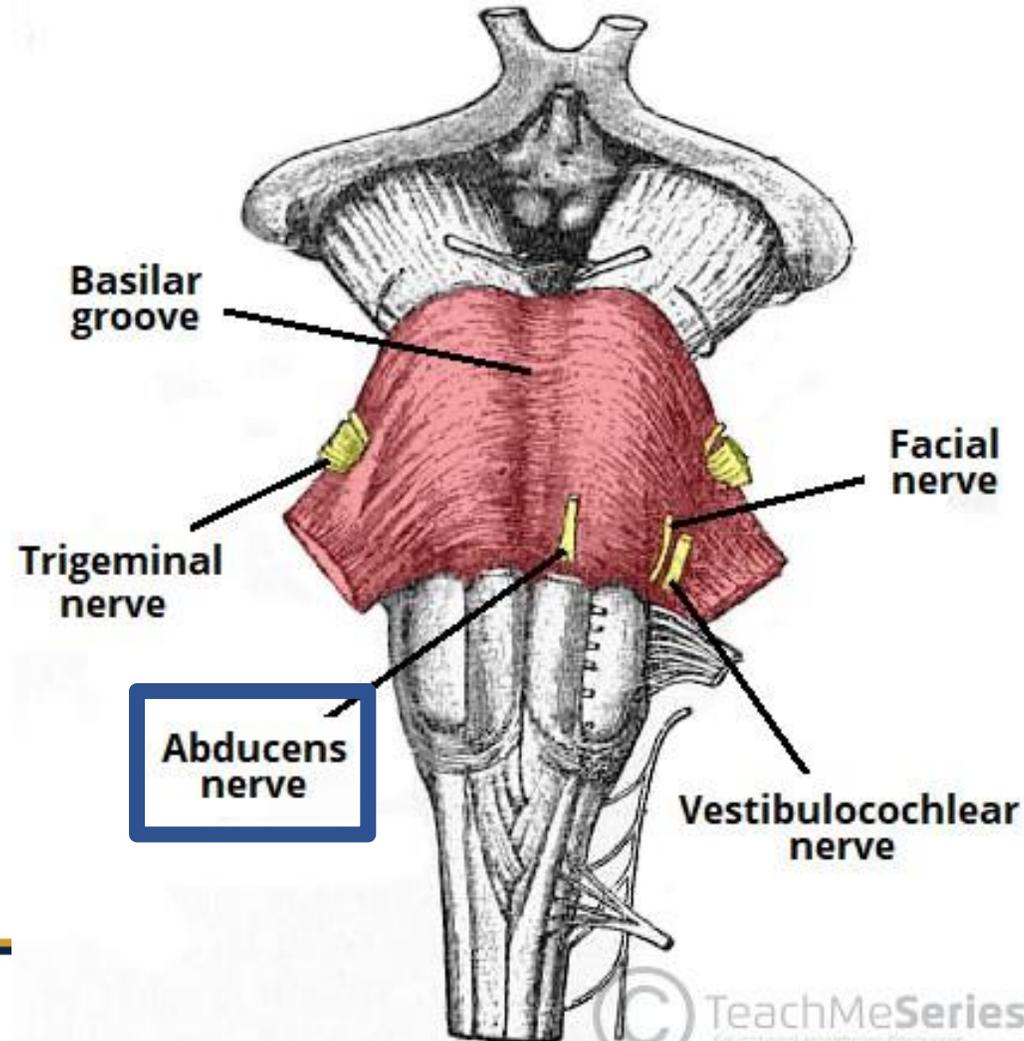
The abducent nerve (CN VI)

- The sixth cranial nerve.
- It has a purely somatic motor function.



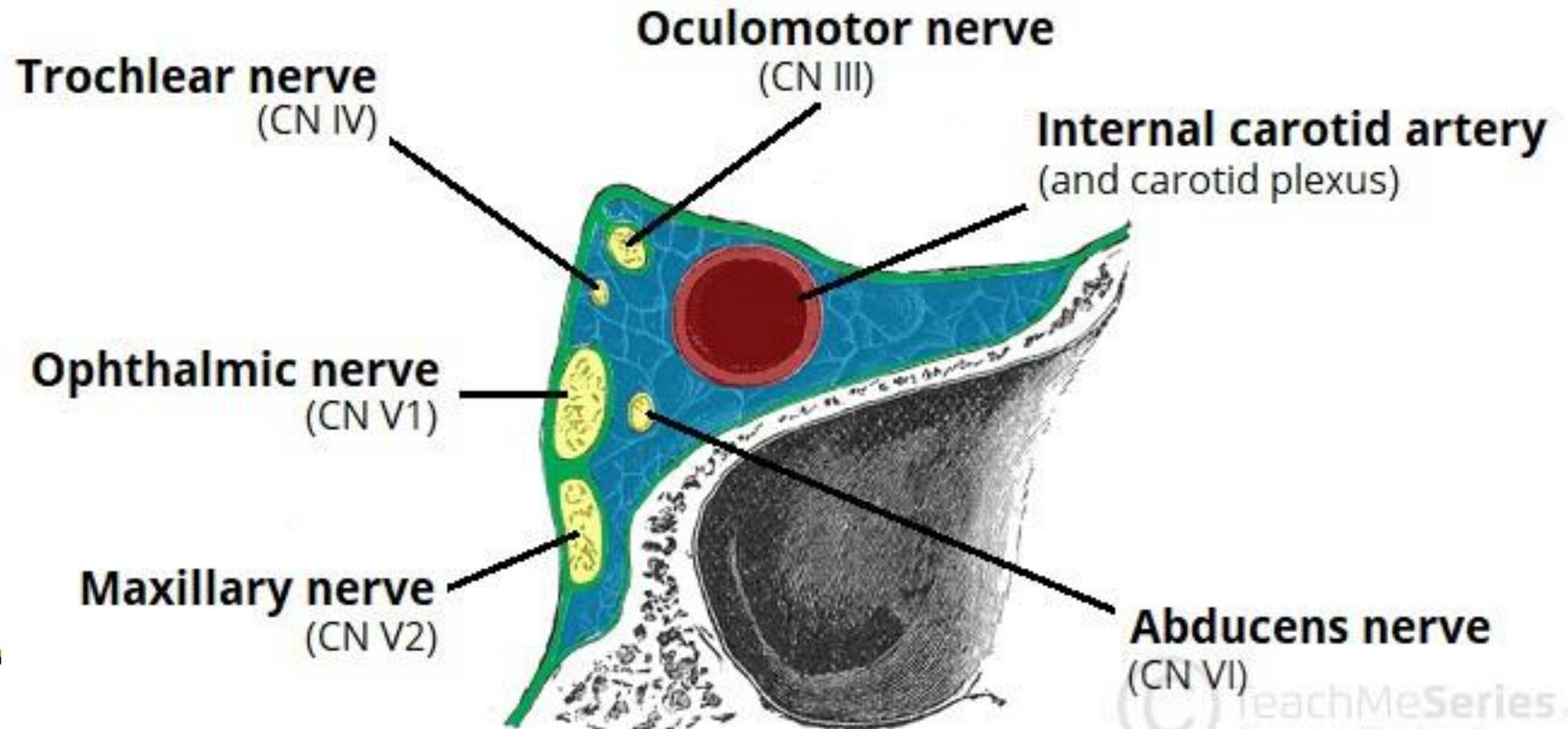
Cranial nerves – CN VI

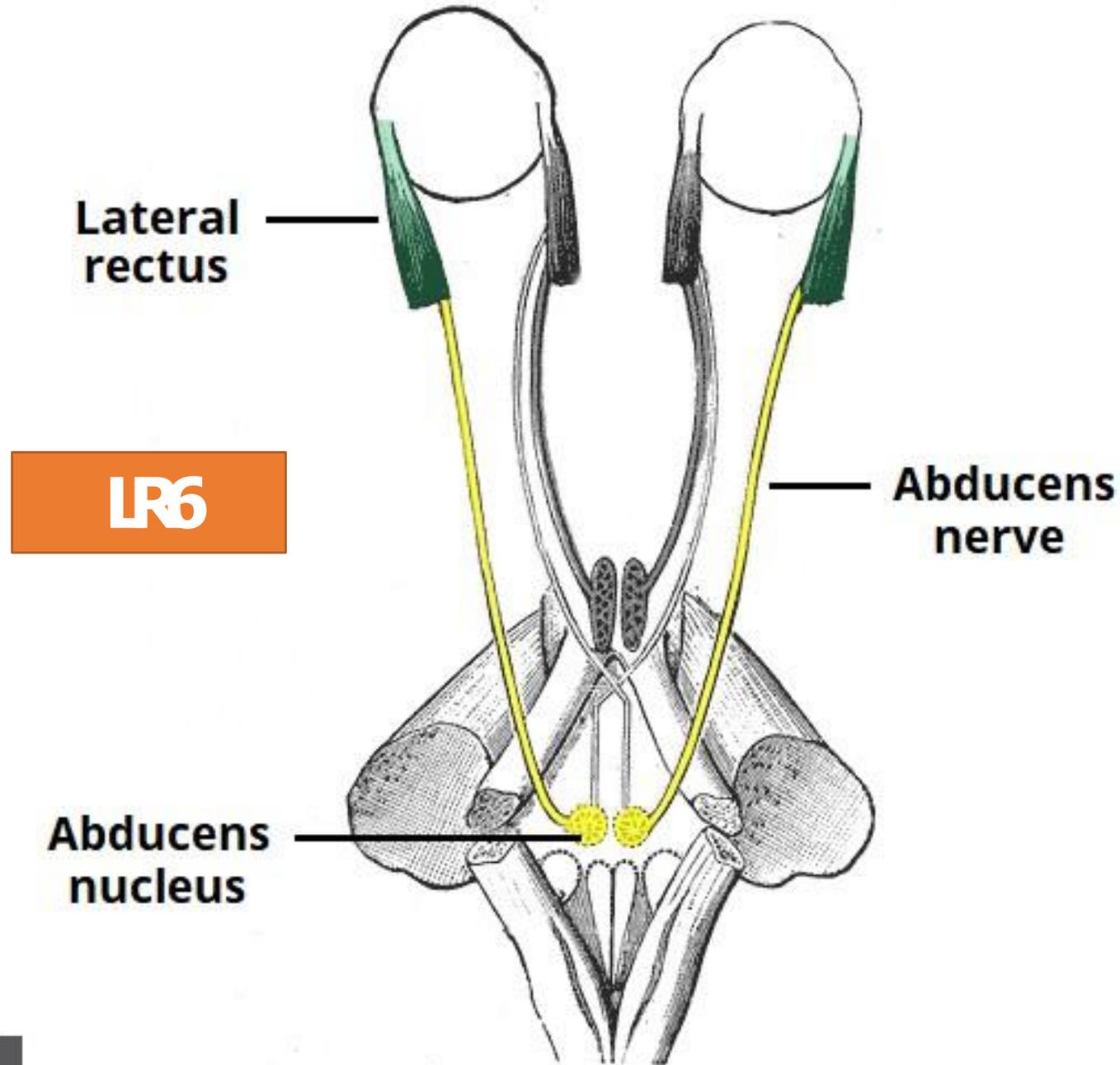
- The abducens nerve arises from the abducens nucleus in the **pons** of the brainstem.



Cranial nerves – CN VI

- Enters the **cavernous sinus**. It travels through the cavernous sinus and enters the bony orbit via the **superior orbital fissure**.
- Within the bony orbit, the abducens nerve terminates by innervating the **lateral rectus** muscle.





Abducens nerve injury



Oculomotor N (III)

Ventral
midbrain

Trochlear N (IV)

Dorsal
midbrain

Abducent N (VI)

Between
Pons & pyramid
of medulla

occulomotor n.

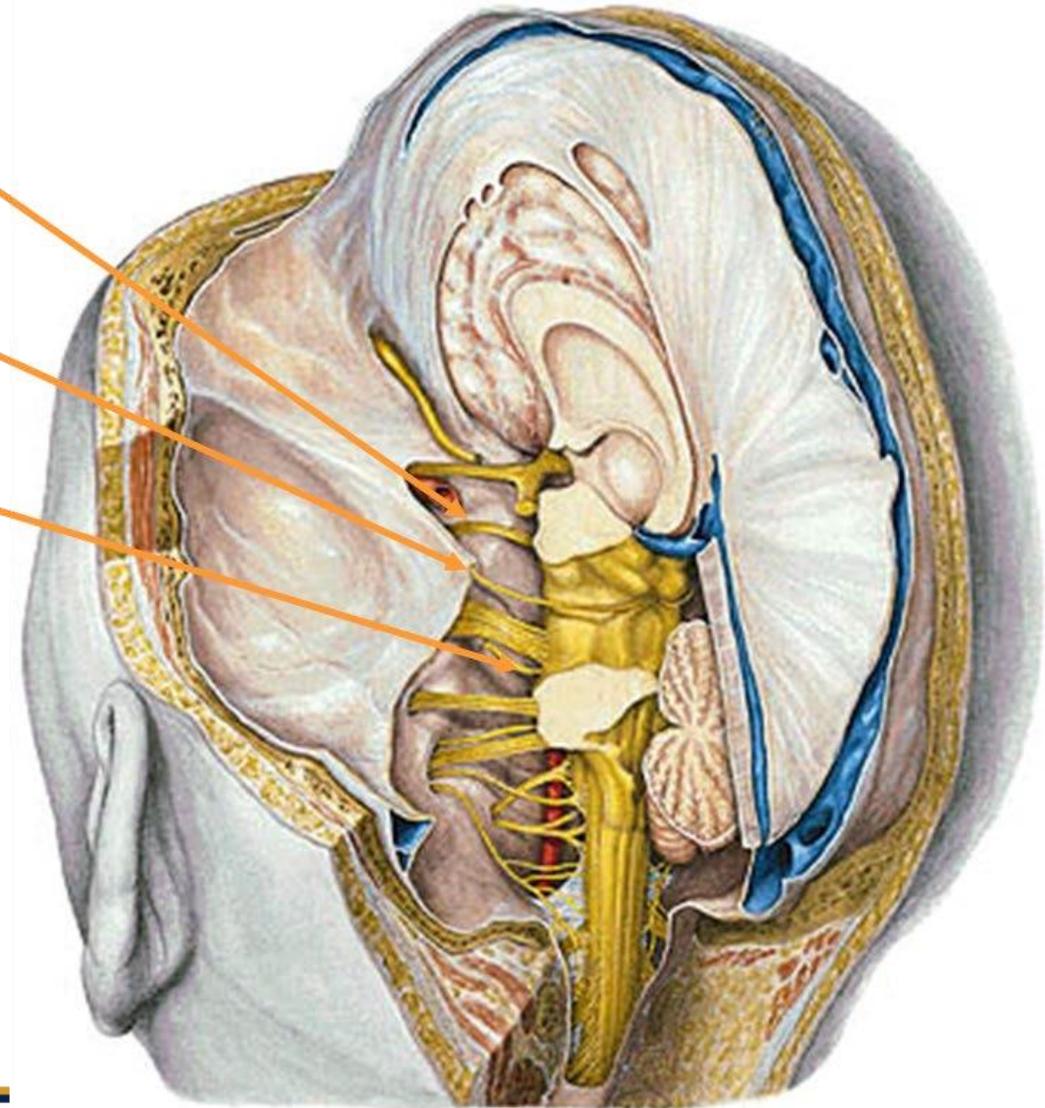
trochlear n.

abducens n.

cavernous sinus

sup. orbital fissure

orbit



SUMMARY TABLE

<u>Number</u>	<u>Name</u>	<u>Exit</u>	<u>Modality</u>	<u>Function</u>
1 (CNI)	Olfactory	Cribriform plate	Sensory (SVA)	Smell
2 (CNII)	Optic	Optic canal	Sensory (SSA)	Vision
3 (CNIII)	Oculomotor	Superior orbital fissure	Motor (GSE & GVE)	GSM: 4 extrinsic eye muscles and levator palpebrae superioris. GVM: pupillary sphincter
4 (CNIV)	Trochlear	Superior orbital fissure	Motor (GSE)	Superior oblique
6 (CNVI)	Abducent	Superior orbital fissure	Motor (GSE)	Lateral rectus



Cranial nerves(9,10,11,12)

- Department of human Anatomy and Embryology Faculty of Medicine
 - Mansoura National University, Egypt



IX. Glossopharyngeal nerve

Type: it is A MIXED nerve.

Deep origin: it has 4 nuclei:

1. Motor nucleus: upper part of nucleus ambiguous.

It supplies the stylopharyngeus muscle.

2. Parasympathetic nucleus: inferior salivatory nucleus.

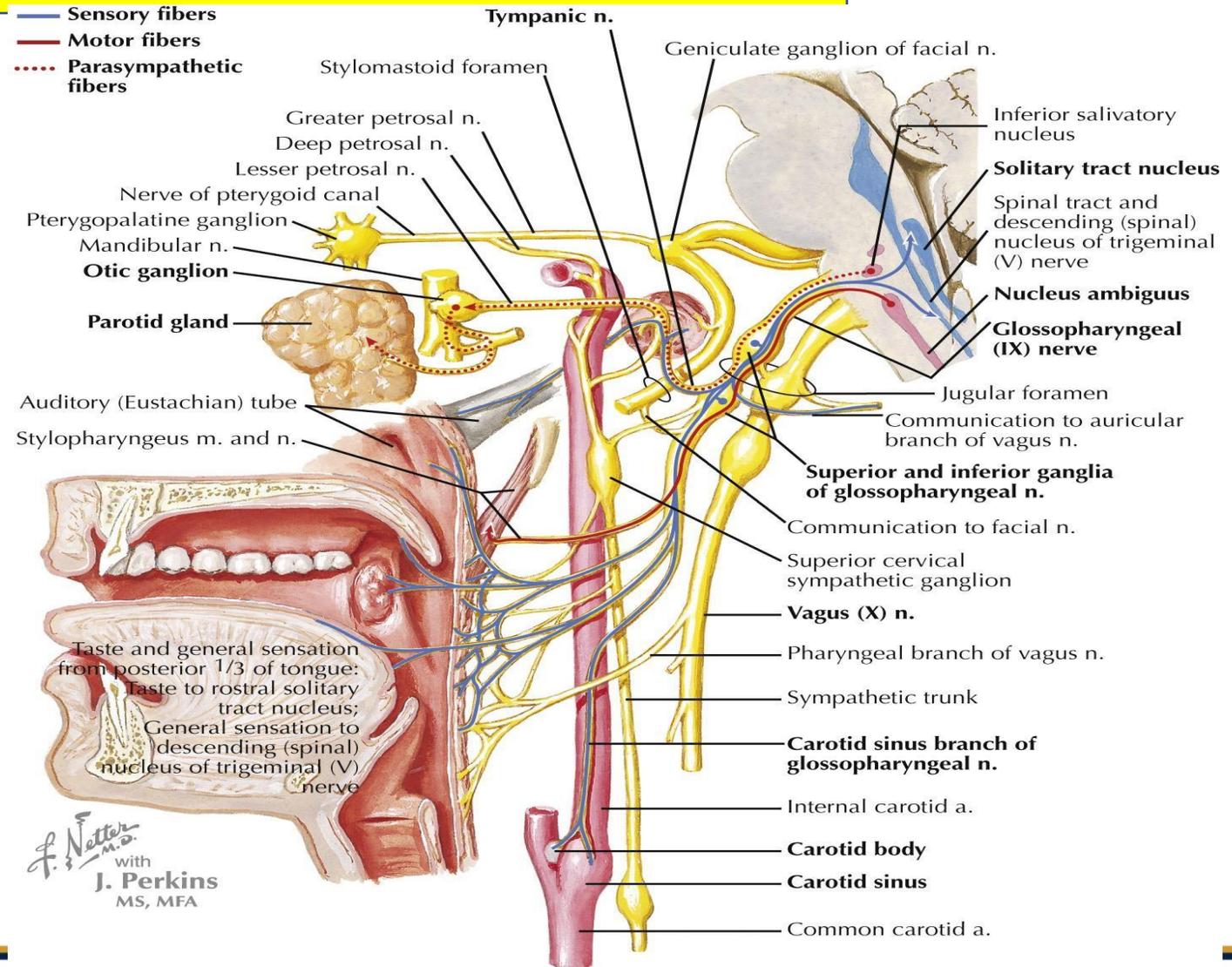
It supplies the parotid gland.

3. Two sensory nuclei:

- **Nucleus solitarius:** it receives taste fibers from the posterior third of the tongue.

- **Spinal trigeminal nucleus:**

- it receives sensory fibers from a small area behind the ear.



X. Vagus Nerve

Type: it is **A MIXED NERVE.**

Deep origin: it has **4 nuclei:**

1. Motor nucleus: middle part of nucleus ambiguous.

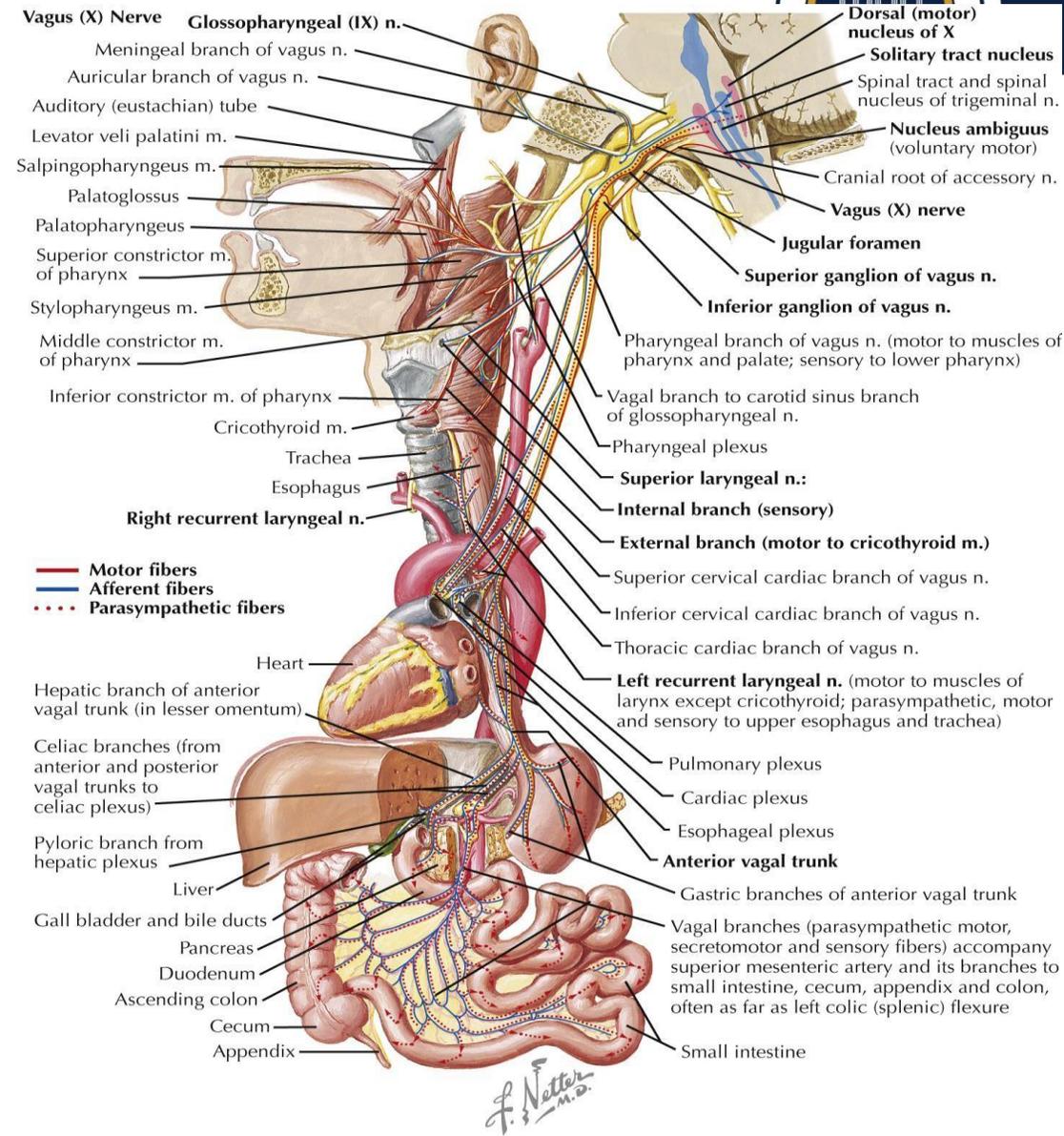
It supplies muscles of the **pharynx** except the **stylopharyngeus**, larynx and palate except the **tensor palati** muscle.

2. Parasympathetic nucleus: dorsal motor nucleus of the vagus. It supplies the thoracic and the abdominal organs as far as the **left colic flexure.**

3. Two sensory nuclei:

- **Nucleus solitarius:** it receives taste fibers from the most posterior part of the tongue and epiglottis. They terminate in the upper third of the nucleus.

- **Spinal trigeminal nucleus:** it receives sensory fibers from the external auditory meatus and tympanic membrane.



XI. Accessory Nerve (CN XI)

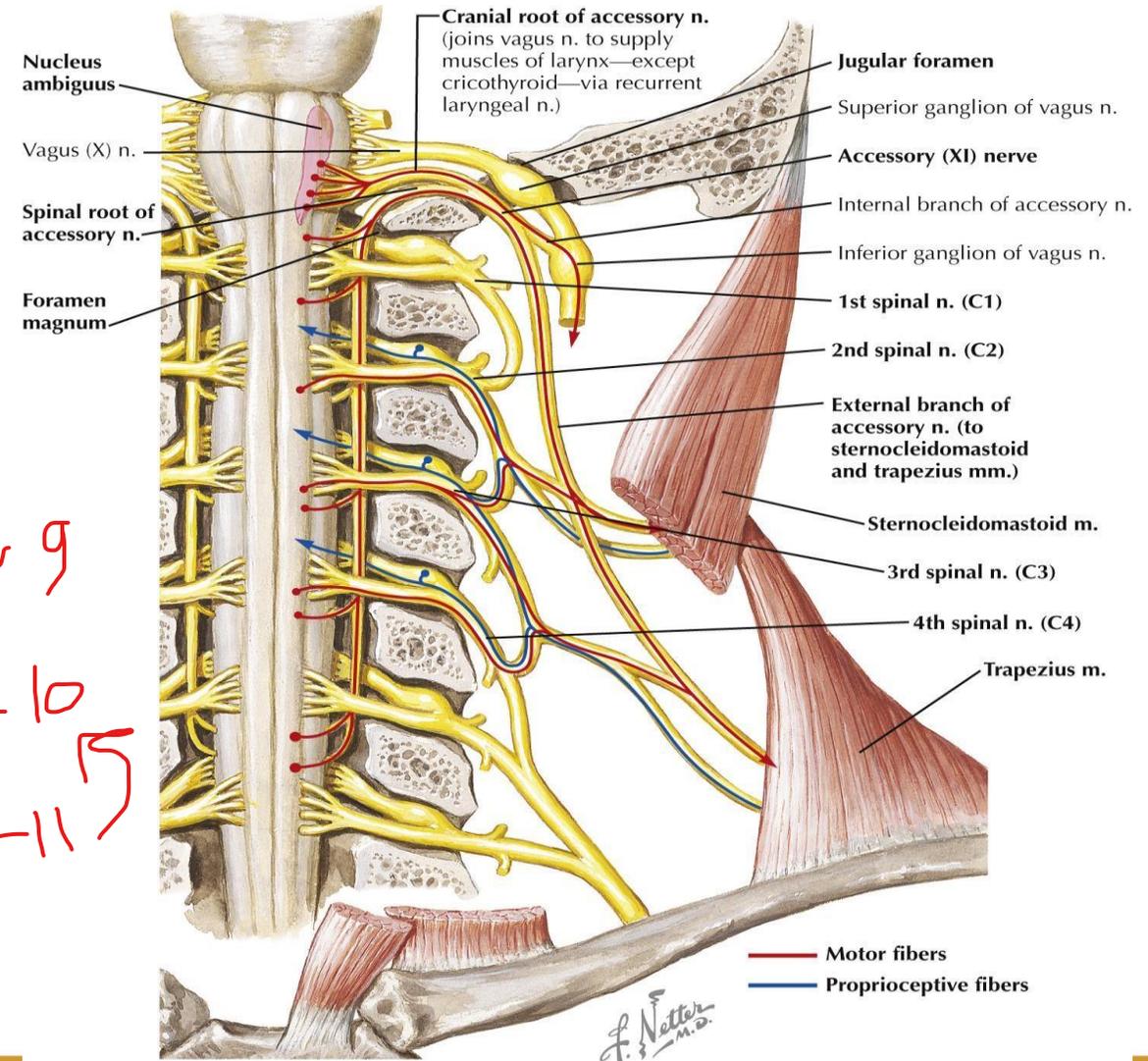
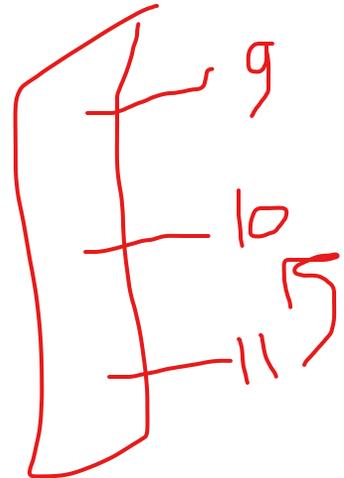
AMBIGUOUS

TYPE: pure **MOTOR** nerve.

ROOTS: It has two roots:

A. Cranial Root:

- It arises from the **lower part** of the nucleus ambiguous.
- It leaves cranial cavity through the **jugular foramen** and joins the vagus nerve.
- It is distributed with **the recurrent laryngeal nerve** to all muscles of the larynx except **the cricothyroid muscle**.



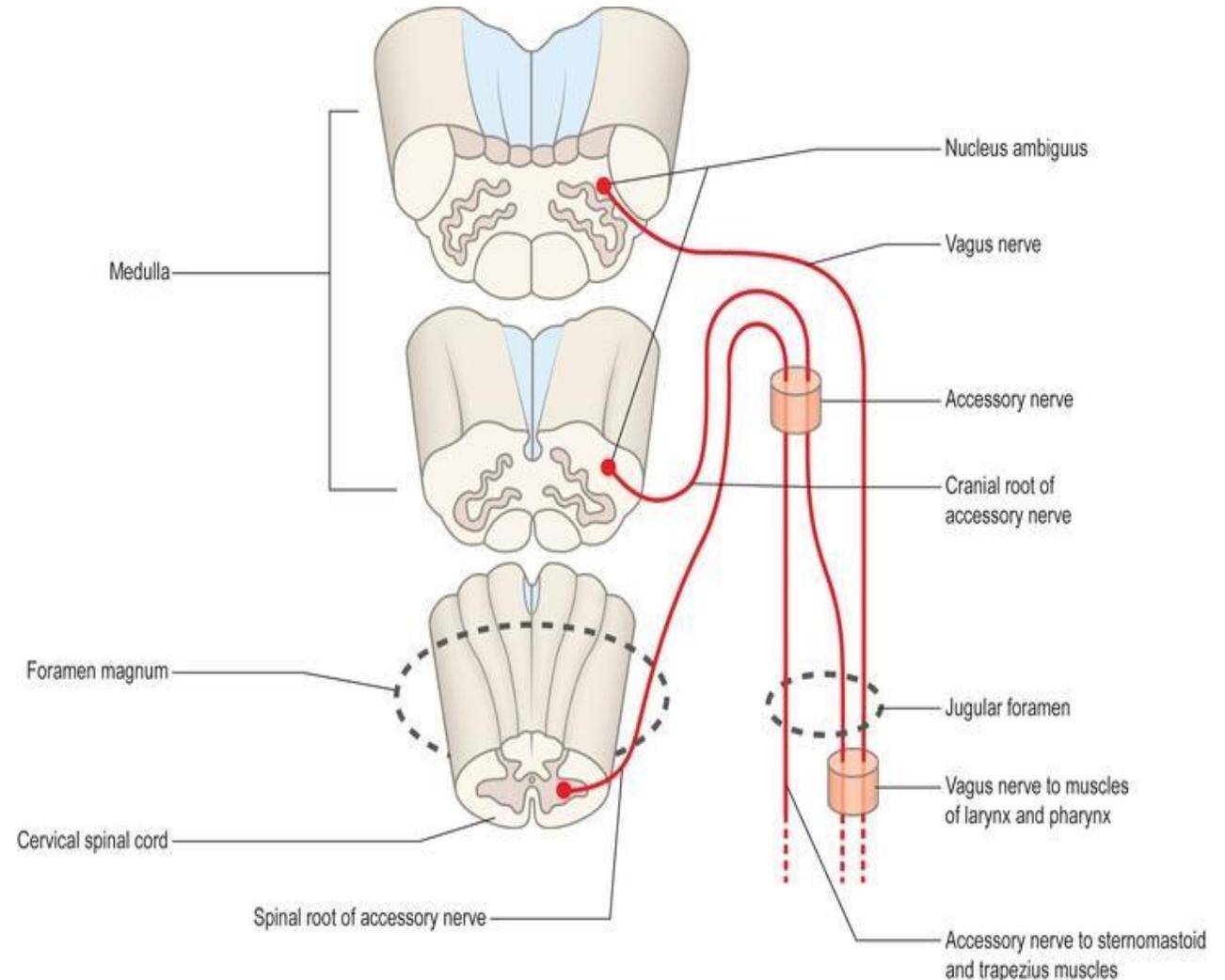
XI. Accessory Nerve (CN XI)

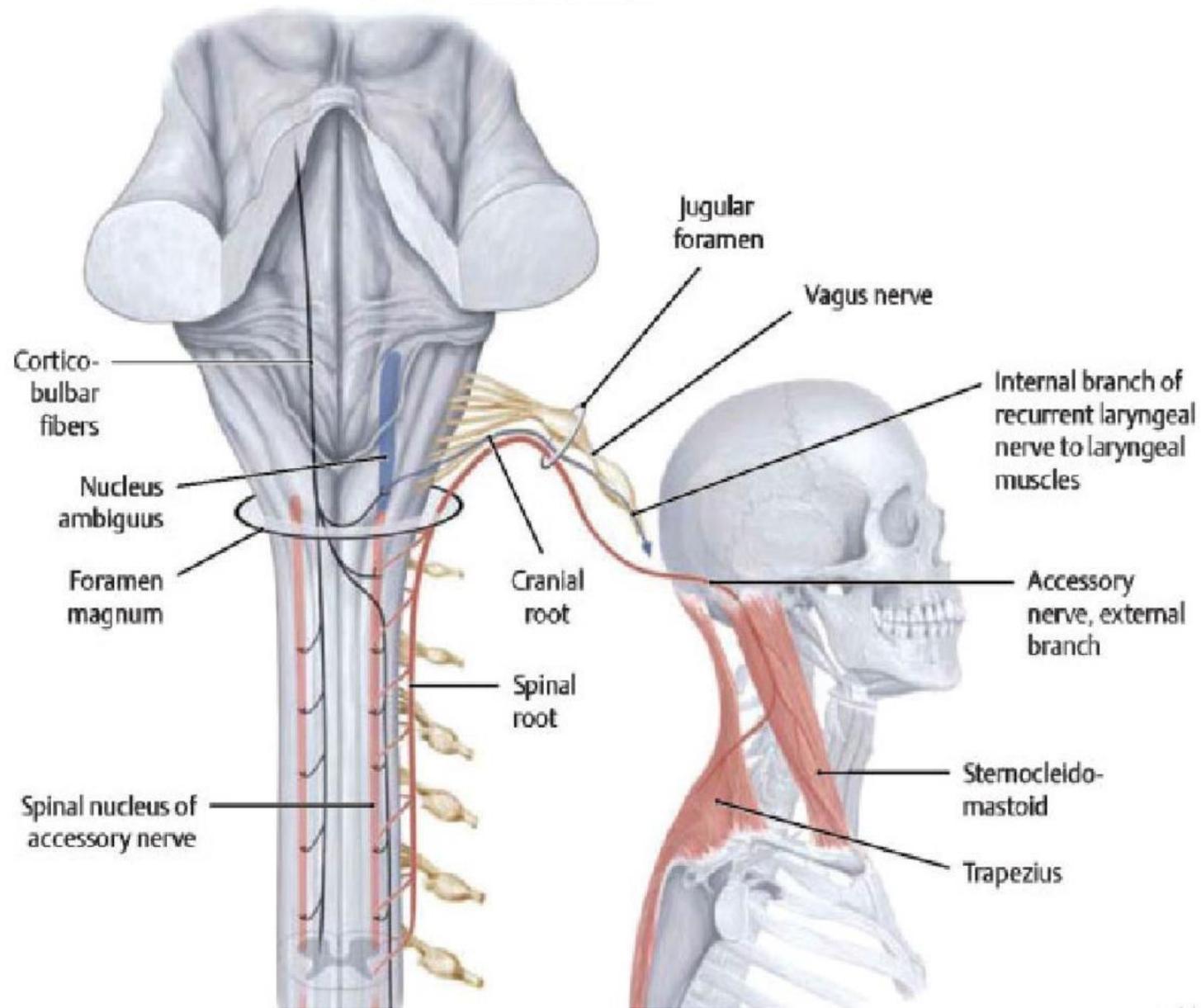
B. Spinal root:

- It arises from the **upper five or six cervical** segments of the spinal cord.
- It supplies the **sternomastoid and trapezius muscles**.
- Lesion of The Spinal Accessory Nerve:**

1. Paralysis of sternomastoid: causes inability to rotate the head to the **opposite side**.

2. Paralysis of trapezius: causes inability to **shrug (up and down)** the shoulder.





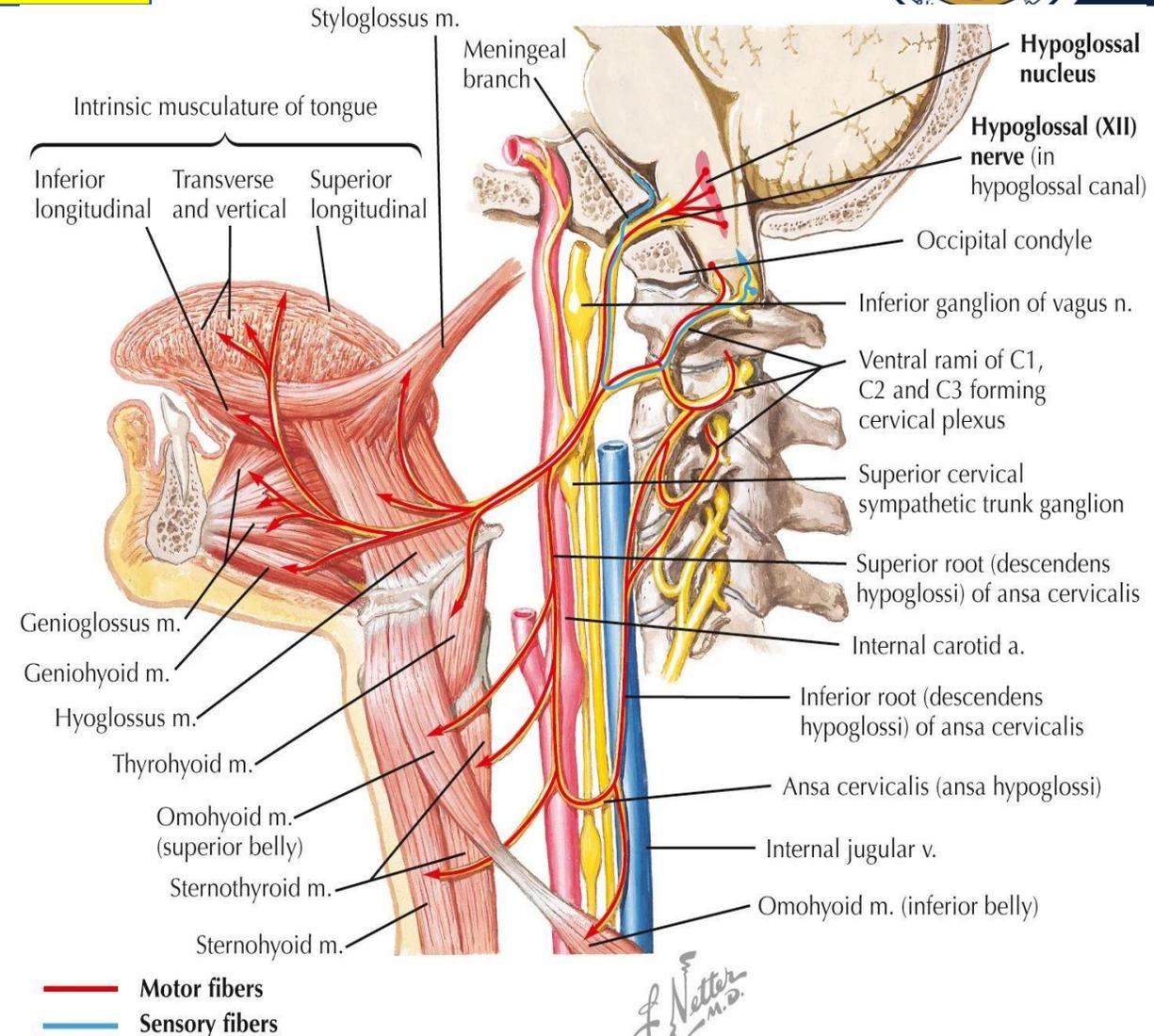
XII. Hypoglossal Nerve (CN XII)

TYPE: It is a pure **MOTOR** nerve.

- It arises from the **hypoglossal nucleus** of the **medulla** in the floor of the 4th ventricle.
- It exits from the **pre-olivary fissure**.
- It supplies all muscles of the tongue except **palatoglossus** muscle.

LESION:

- LMN paralysis** of the **same side** of the tongue (hemiparalysis).
- Deviation of the protruded tongue toward **the affected side**.





Trigeminal system

Department of human Anatomy and Embryology
Faculty of Medicine
Mansoura National University, Egypt



By

Dr. Fekry Shata



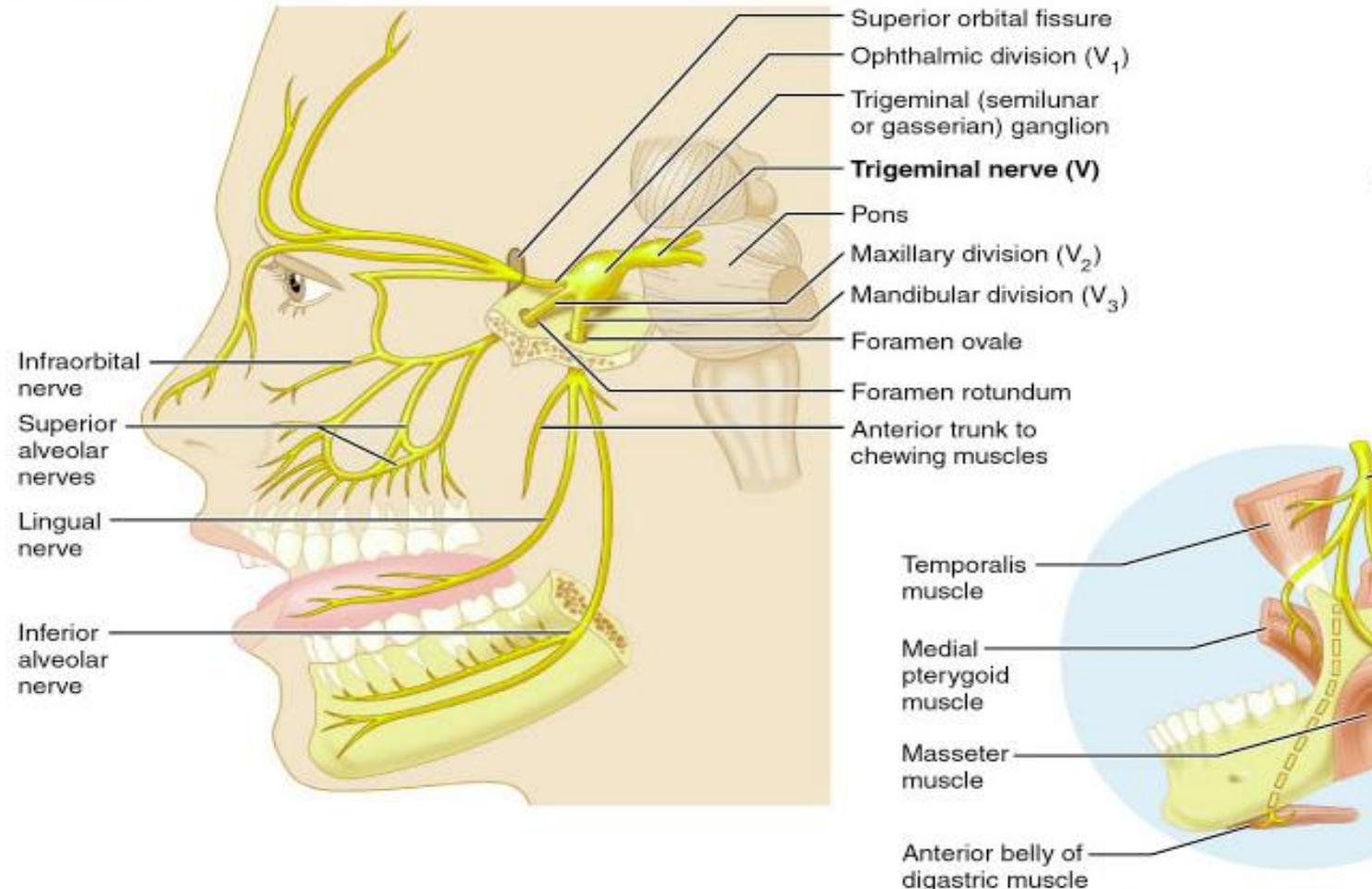


Trigeminal System



Trigeminal nerve (CN V)

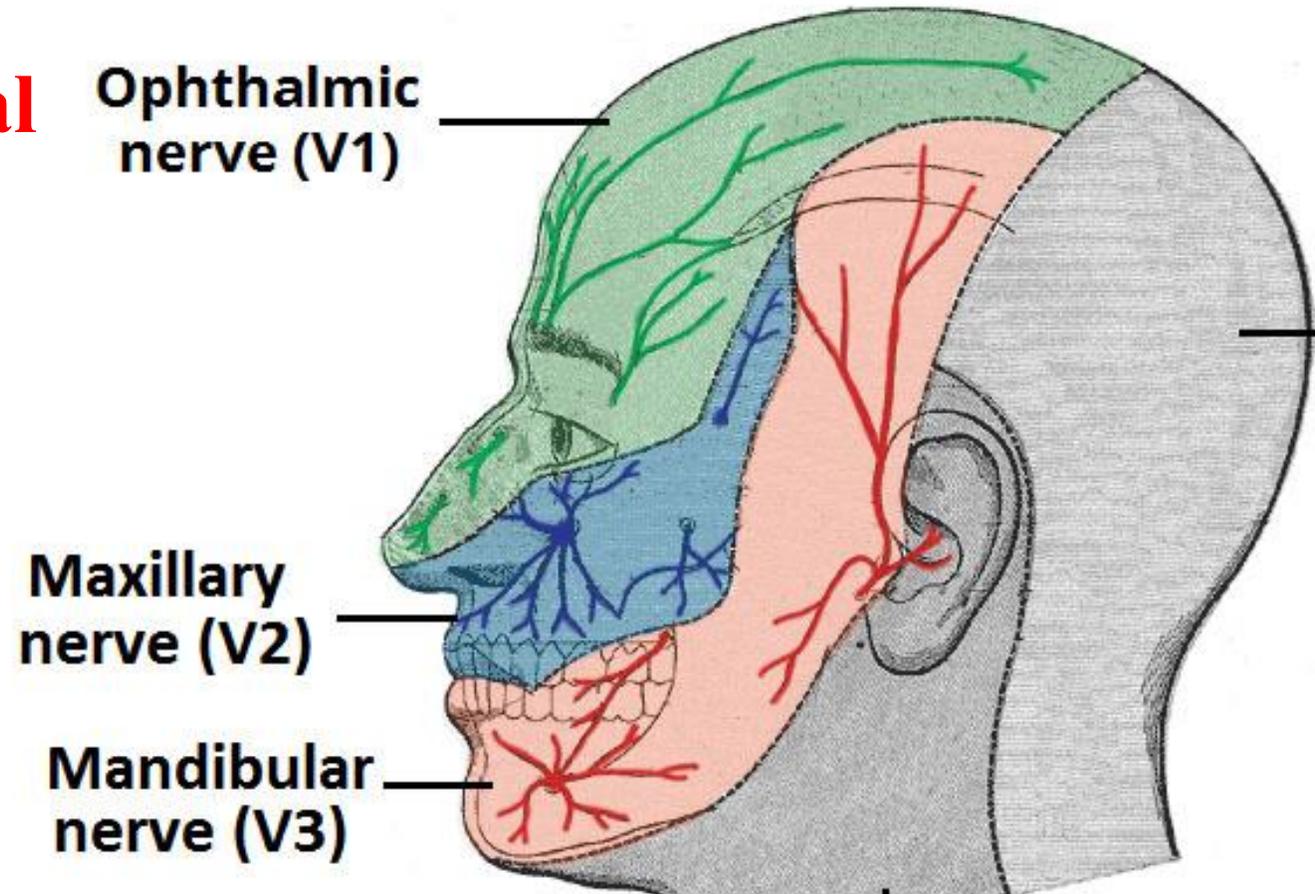
- Is the **fifth** cranial nerve.
- Is the **largest cranial nerve**.
- **Type: mixed** (sensory, motor & parasympathetic).



Trigeminal nerve (CN V)

- The trigeminal nerve **supply the derivatives of the 1st pharyngeal arch** (4 muscles of mastication, anterior belly of the digastric and mylohyoid, tensor palatae and tensor tympani)..

1. Sensory: The three terminal branches of CN V innervate the skin, mucous membranes and sinuses of the face.



The trigeminal nerve (CN V)

2. Motor: Only the **mandibular** branch of CN V has **motor** fibers.

- ❑ It innervates the **muscles of mastication**: medial pterygoid, lateral pterygoid, masseter and temporalis.
- ❑ It also supplies **1st pharyngeal arch muscles**: anterior belly of digastric, mylohyoid, tensor palati and tensor tympani.

3. Parasympathetic Supply: The post-ganglionic neurons of **parasympathetic ganglia** travel with branches of the trigeminal nerve.

(Note that CN V is NOT part of the cranial outflow of PNS supply)

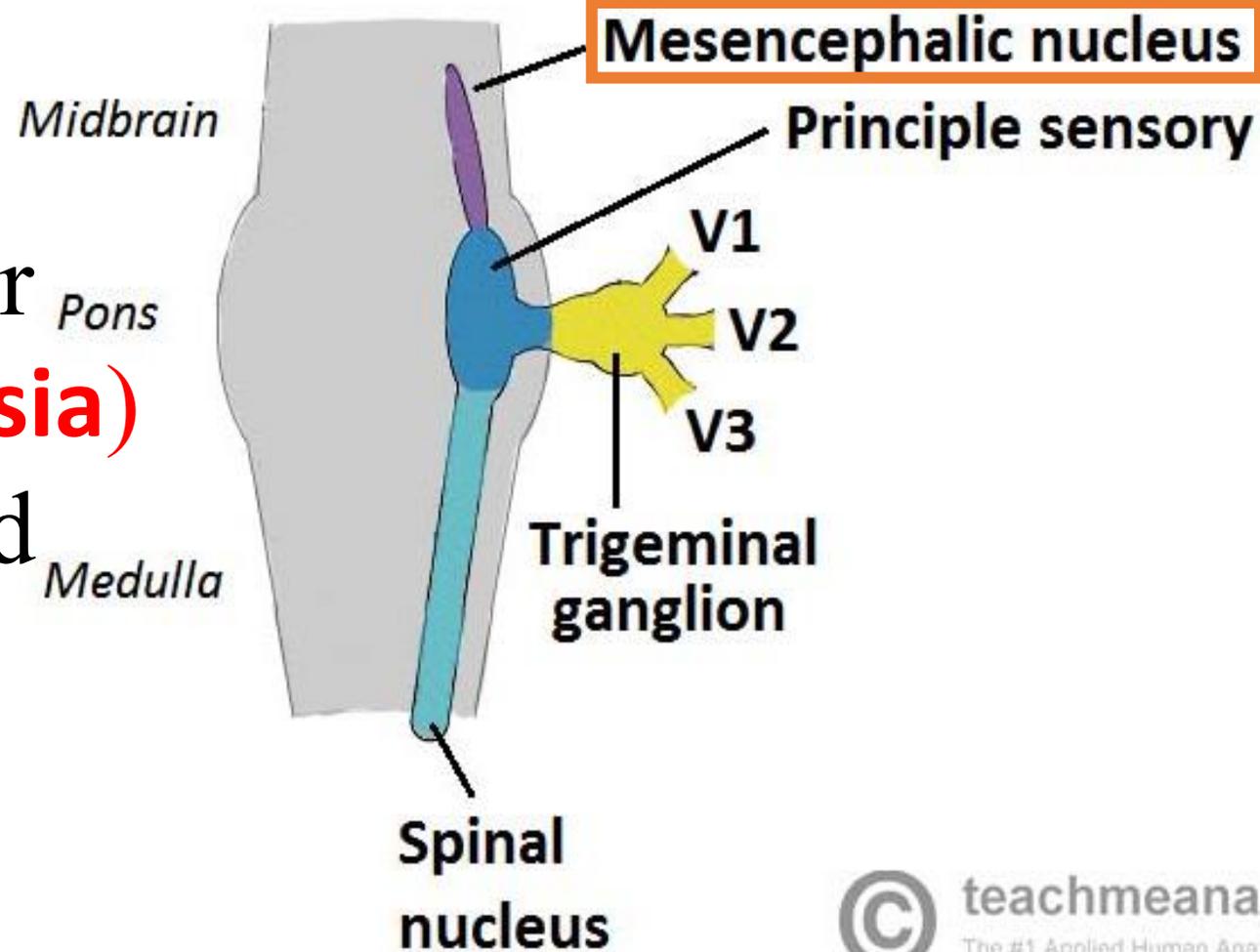


Nuclei of Trigeminal Nerve



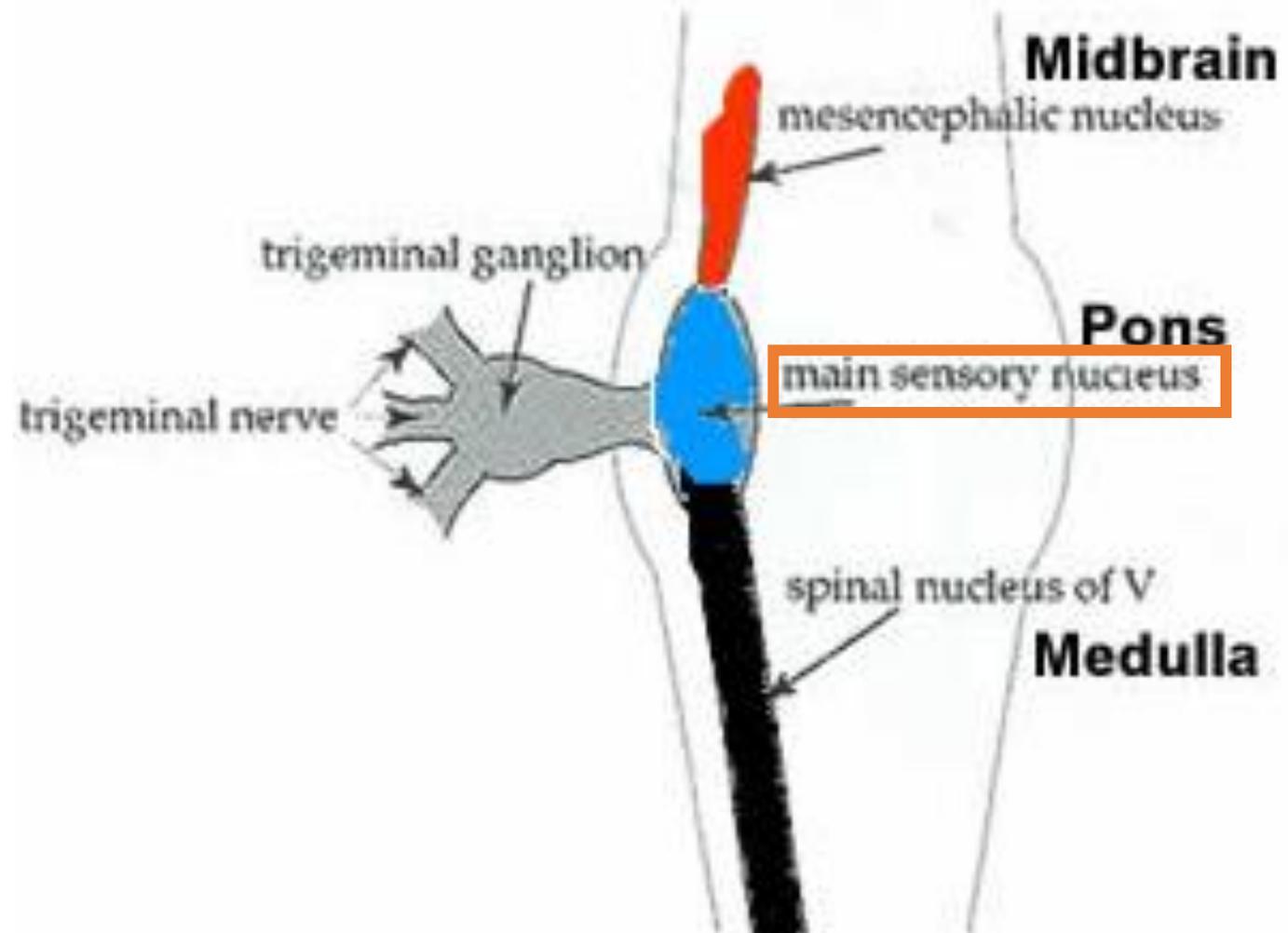
1. Mesencephalic nucleus

- In **midbrain**.
- Is the first-order neuron for **proprioception or (kinesthesia)** from the muscles of the head and from the temporomandibular joint



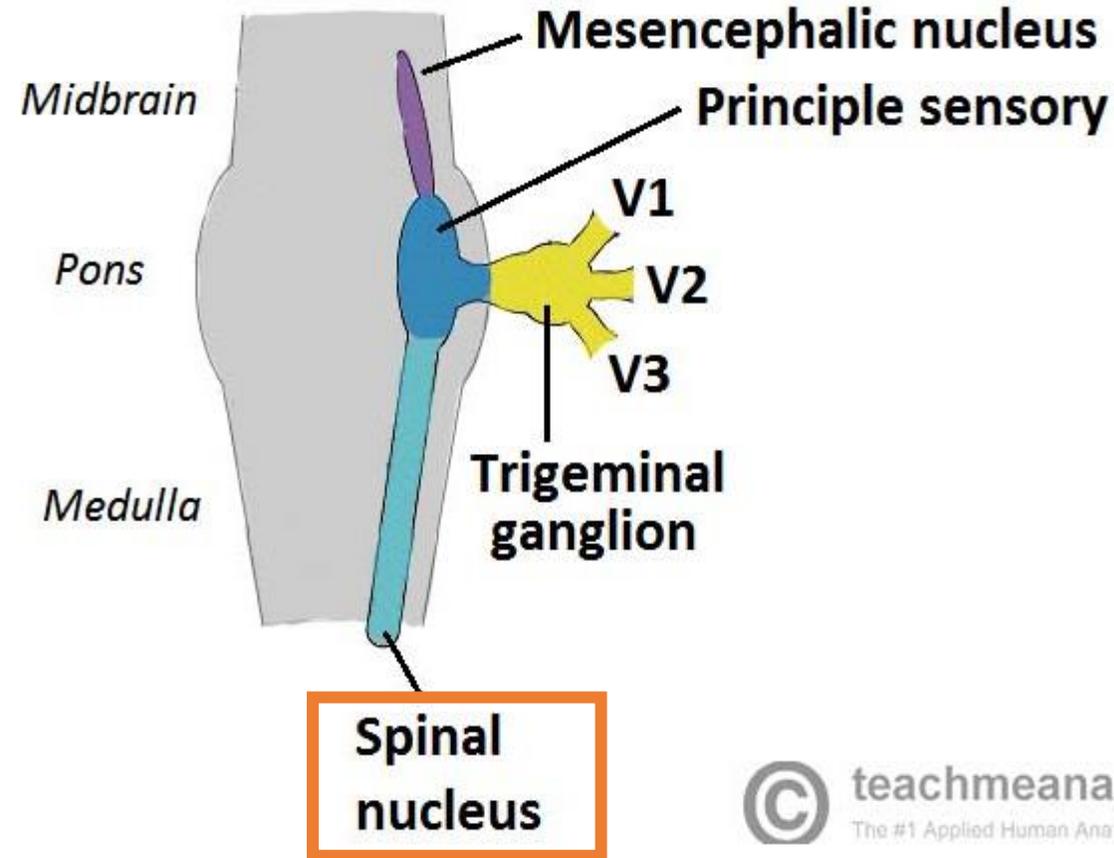
2. Main sensory nucleus

- In upper **pons**.
- It mediates **discriminative touch and pressure** sensations from the same side of the face



3. Spinal nucleus

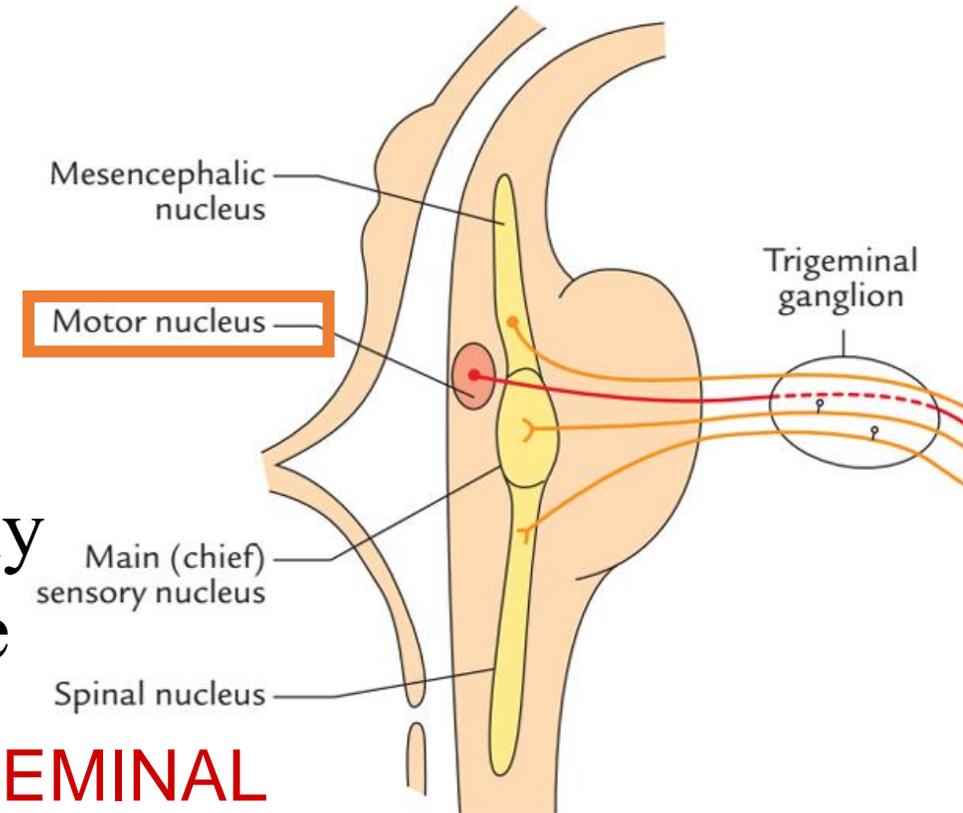
- In upper **pons**, **medulla** down to C2 segment of **spinal cord**. (**pain and temperature**).
- It mediates pain and temperature sensations from the same side of the face



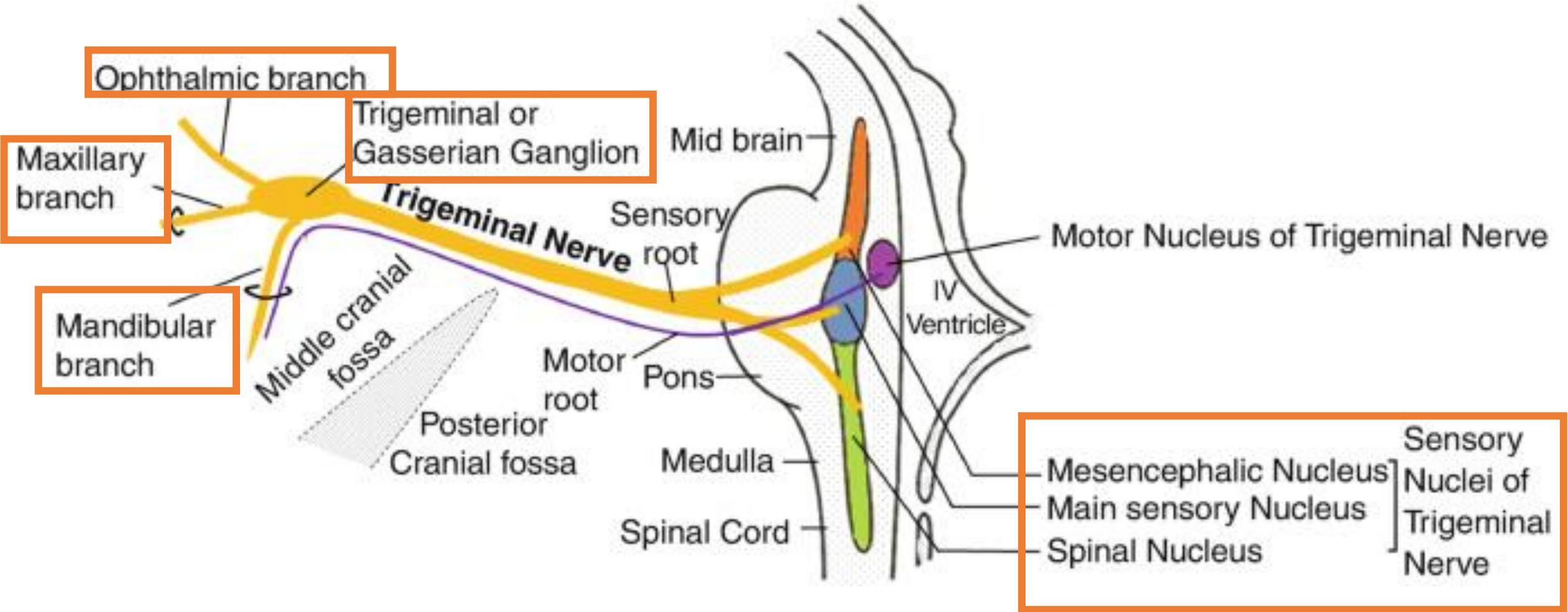
4. Motor nucleus

- In upper **pons**.
- Forms the **motor root** of the trigeminal nerve.
- It supplies muscles of the **1st pharyngeal arch** (4 muscles of mastication, anterior belly of the digastric and mylohyoid, tensor palate and tensor tympani).

SAQ: NUCLEI OF TRIGEMINAL



Trigeminal Ganglion





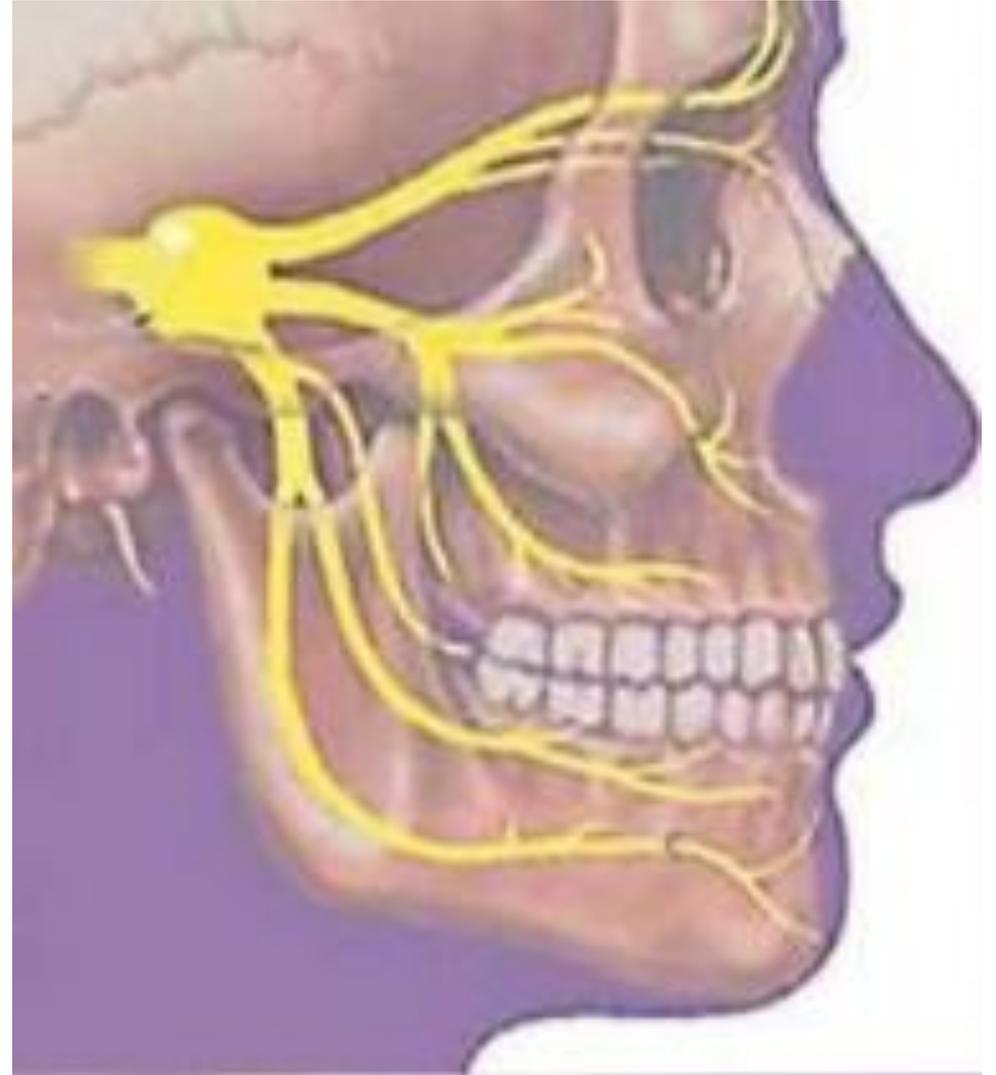
Divisions of Trigeminal Nerve



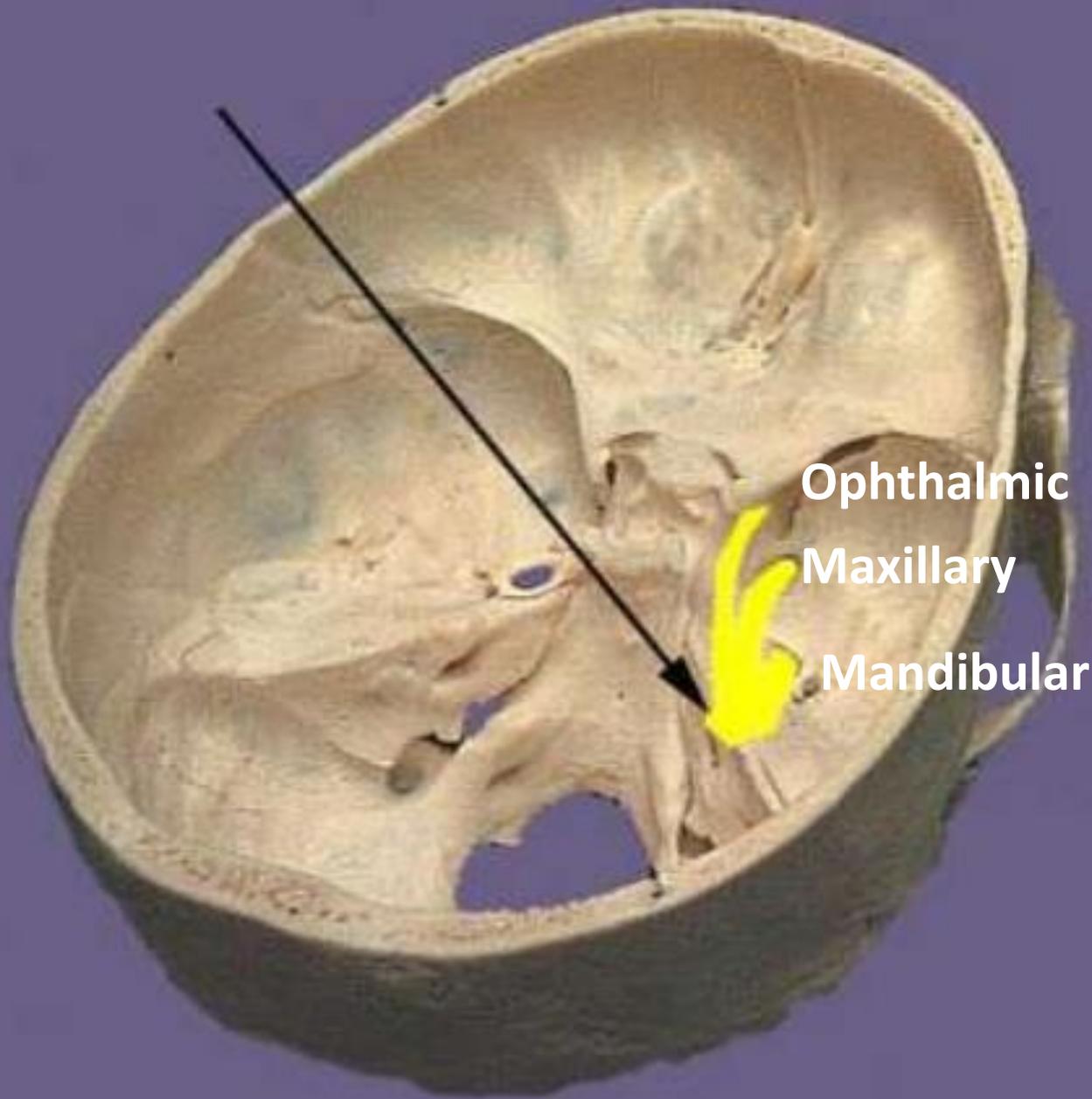
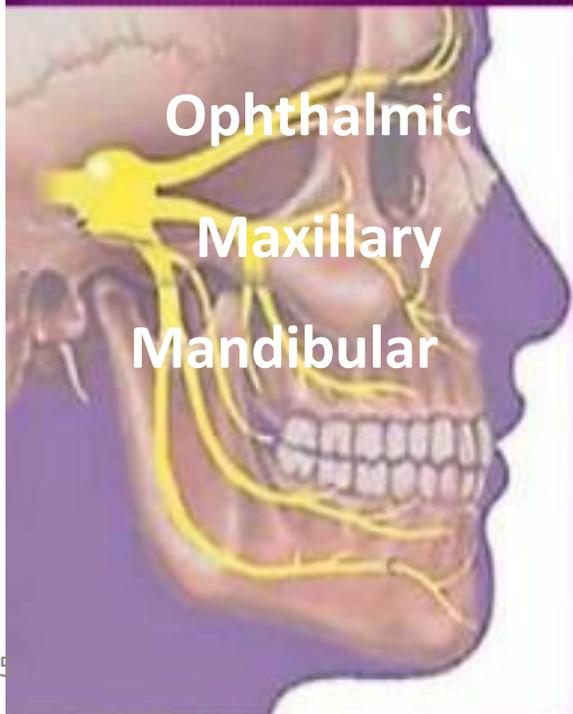
The trigeminal ganglion gives rise to 3 divisions:

1. **Ophthalmic (V1)**
2. **Maxillary (V2)**
3. **Mandibular (V3)**

SAQ



EXIT FROM SKULL



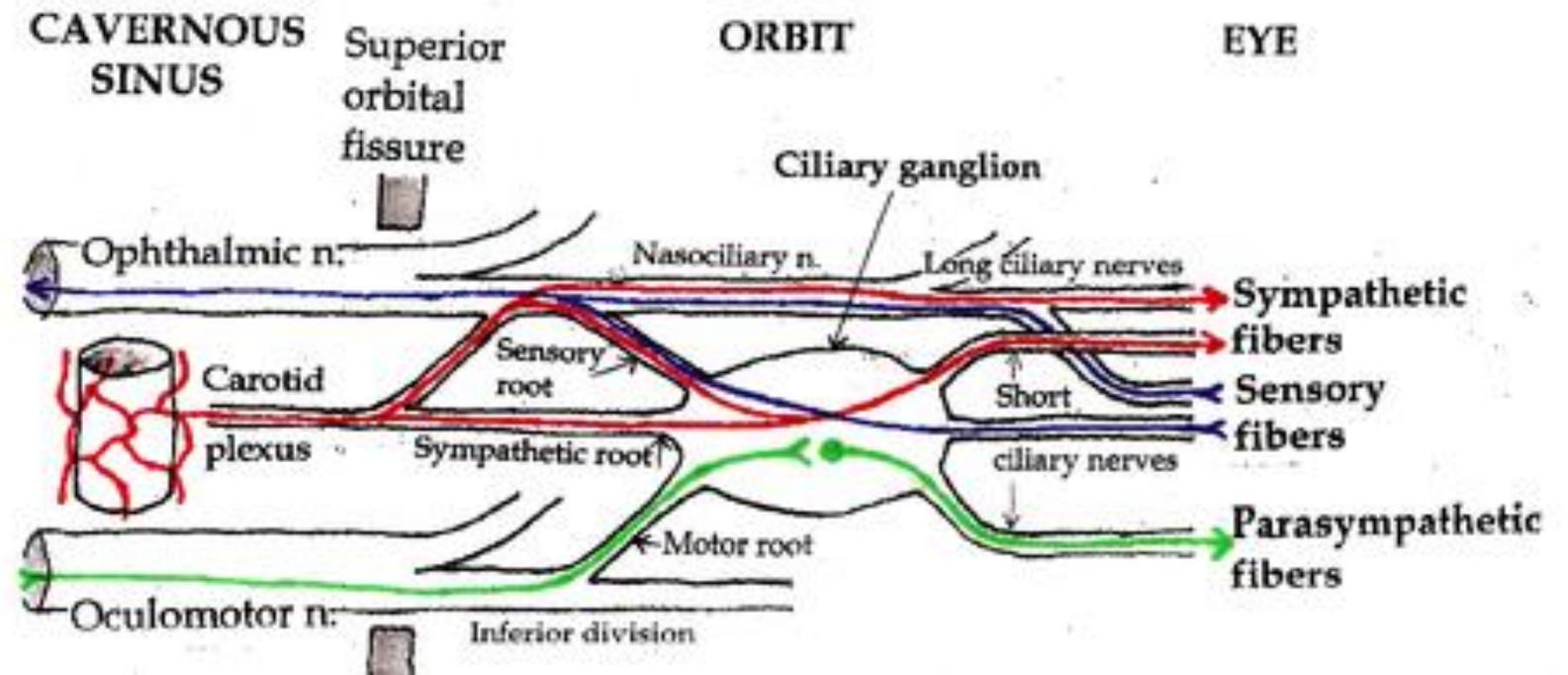


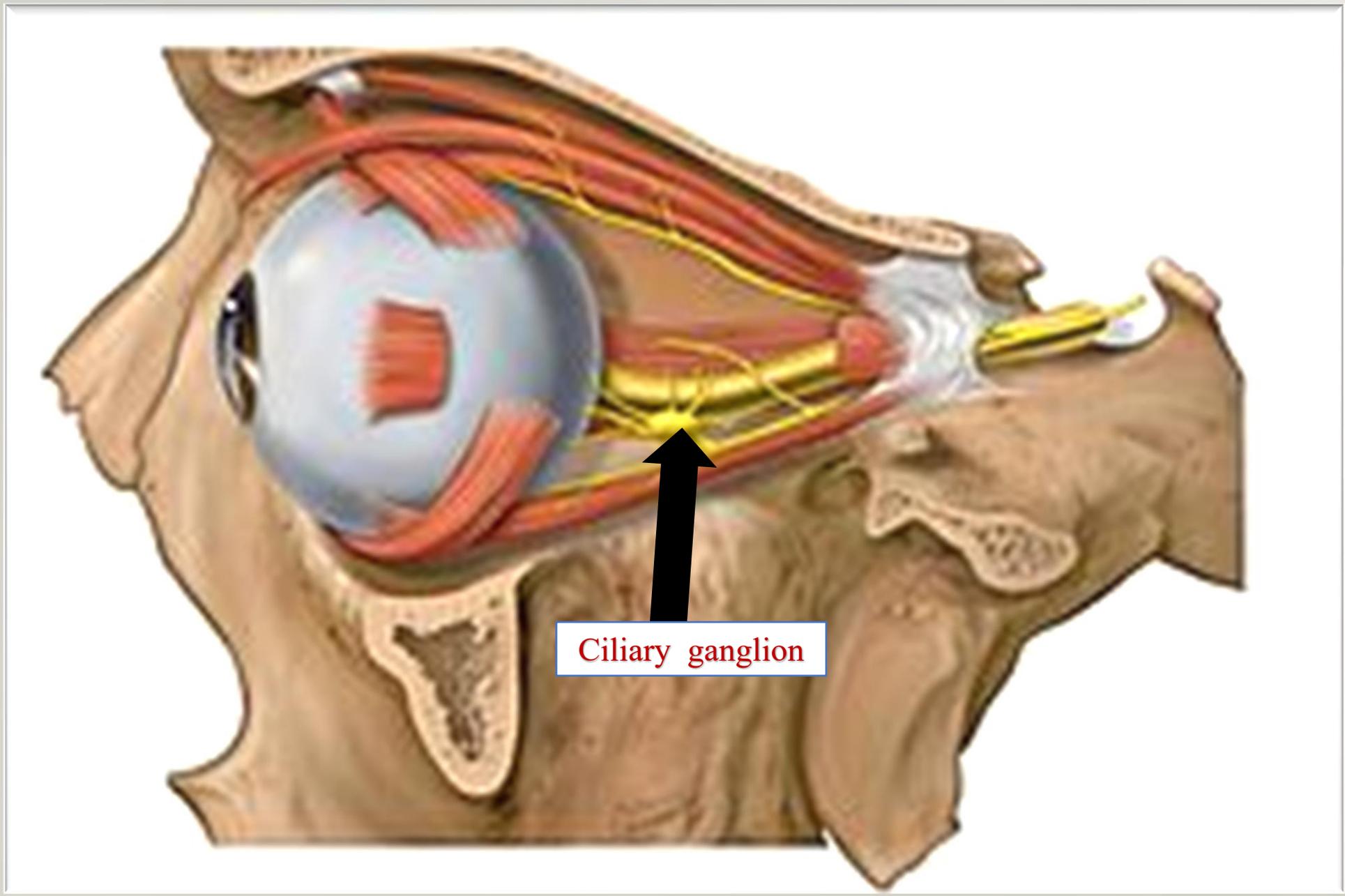
GANGLIA ASSOCIATED WITH TRIGEMINAL NERVE



1. CILLIARY GANGLION

- Connected with **nasociliary nerve**
- **Responsible for accommodation through oculomotor nerve**



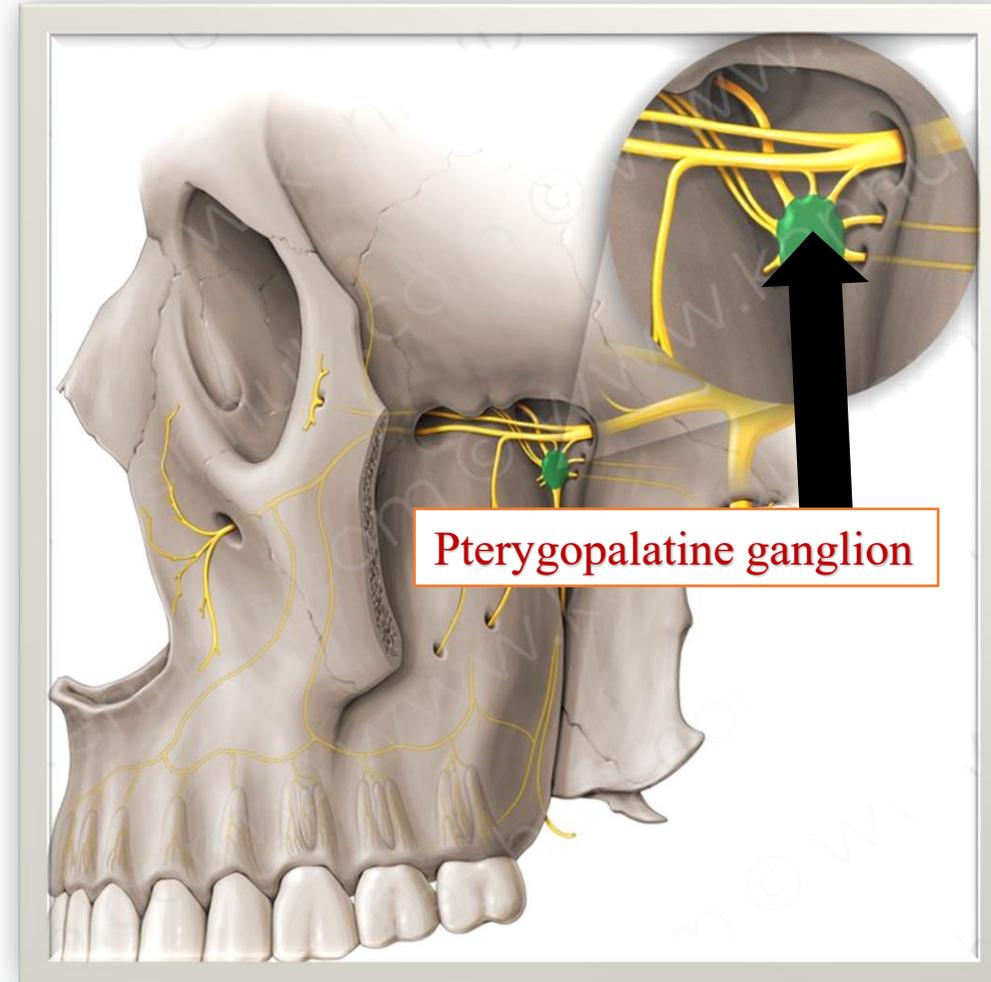


Ciliary ganglion



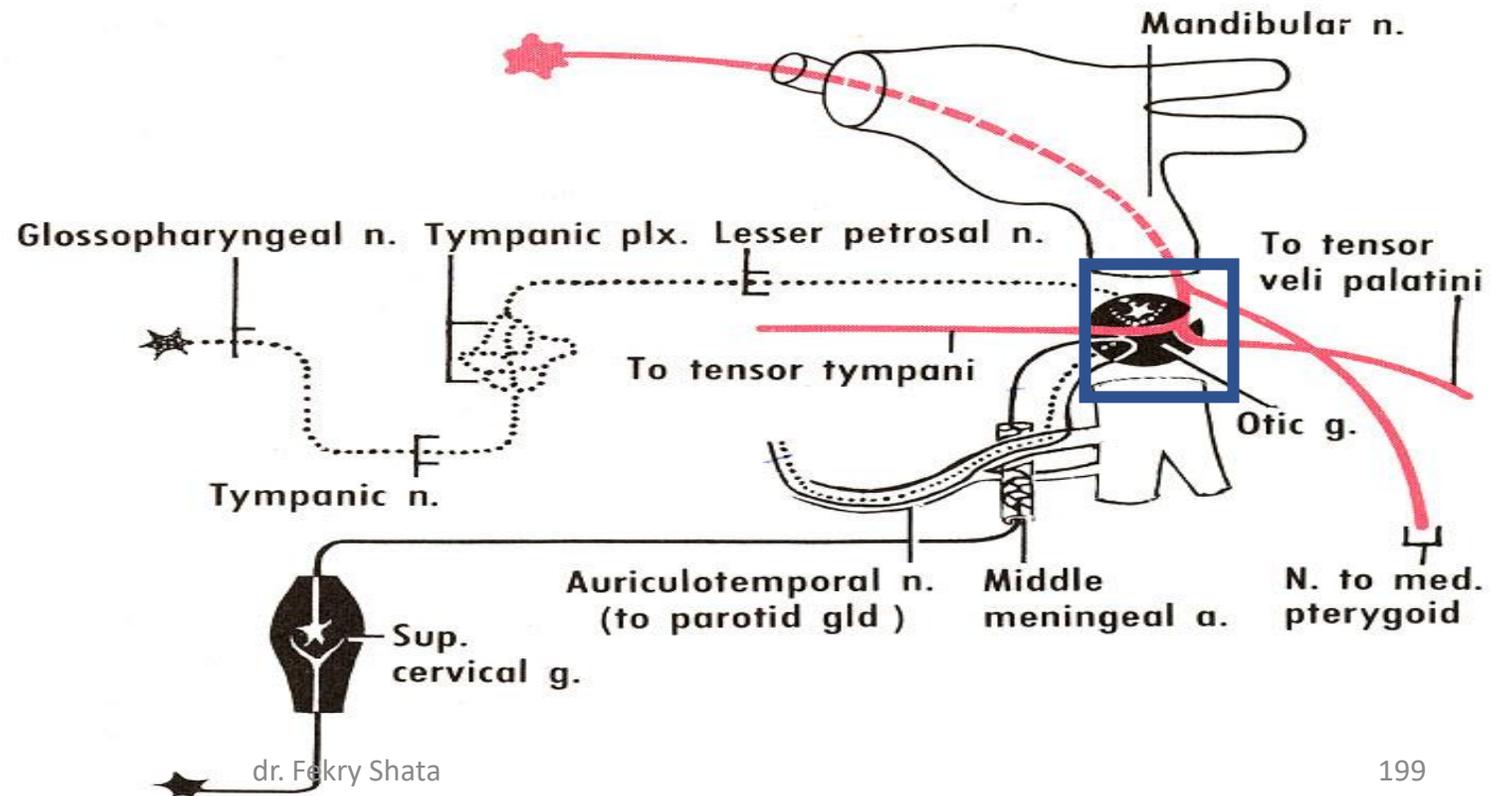
2.PTERYGOPALATINE

- Connected to **maxillary nerve** in infratemporal fossa
- **Secretomotor fibers to lacrimal gland through Facial nerve**



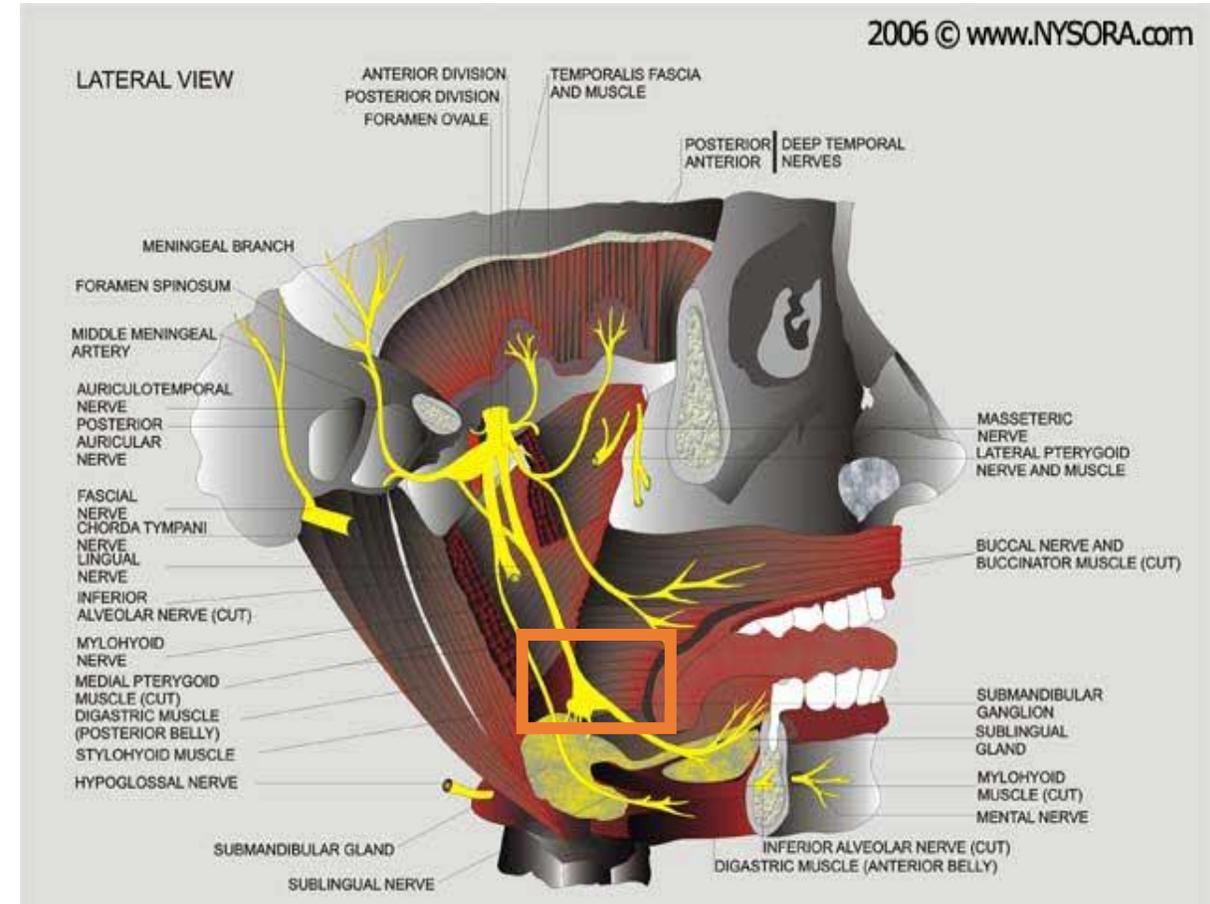
3. OTIC GANGLION

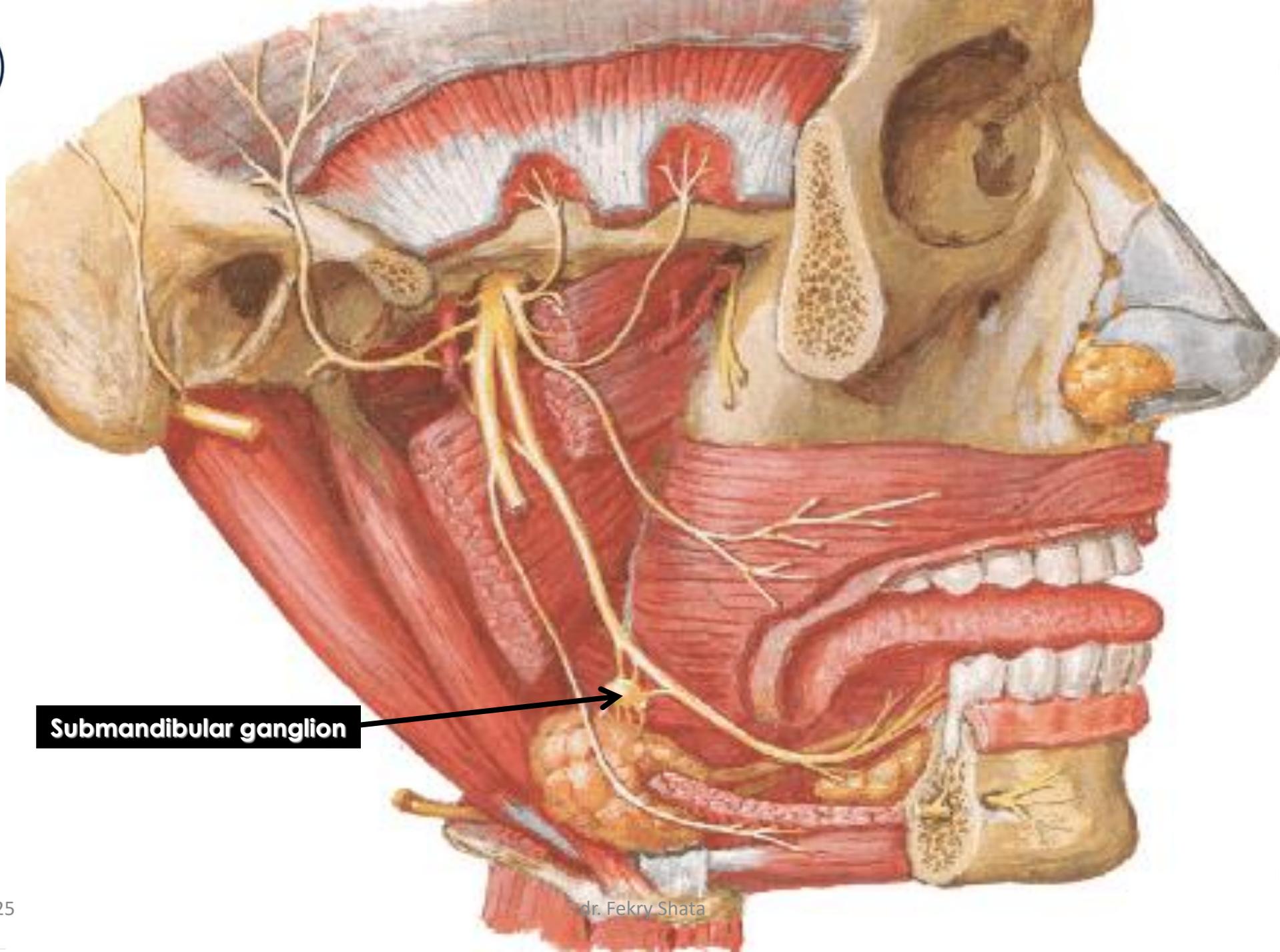
- Lies deep to the **trunk of mandibular nerve**.
- **Secretomotor fibers to parotid gland through glossopharyngeal nerve**



4. Submandibular

- Related to **lingual nerve**, rest on hyoglossus.
- Supplies posterior ganglionic
- **Secretomotor fibres to submandibular and sublingual gland through Facial.**





Submandibular ganglion



Ear and Facial Nerve Vestibulo-Cochlear Nerve

Department of human Anatomy and Embryology
Faculty of Medicine
Mansoura National University, Egypt

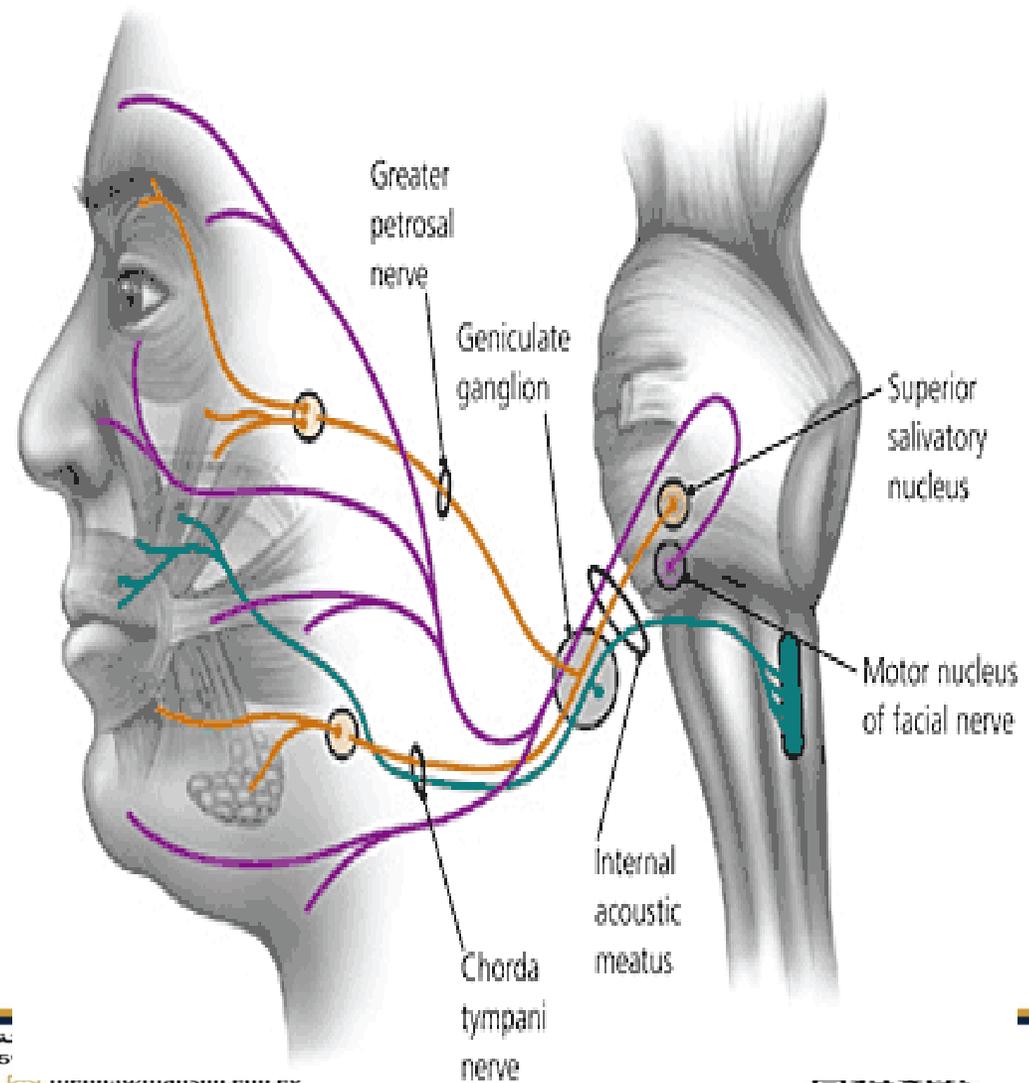
M N U



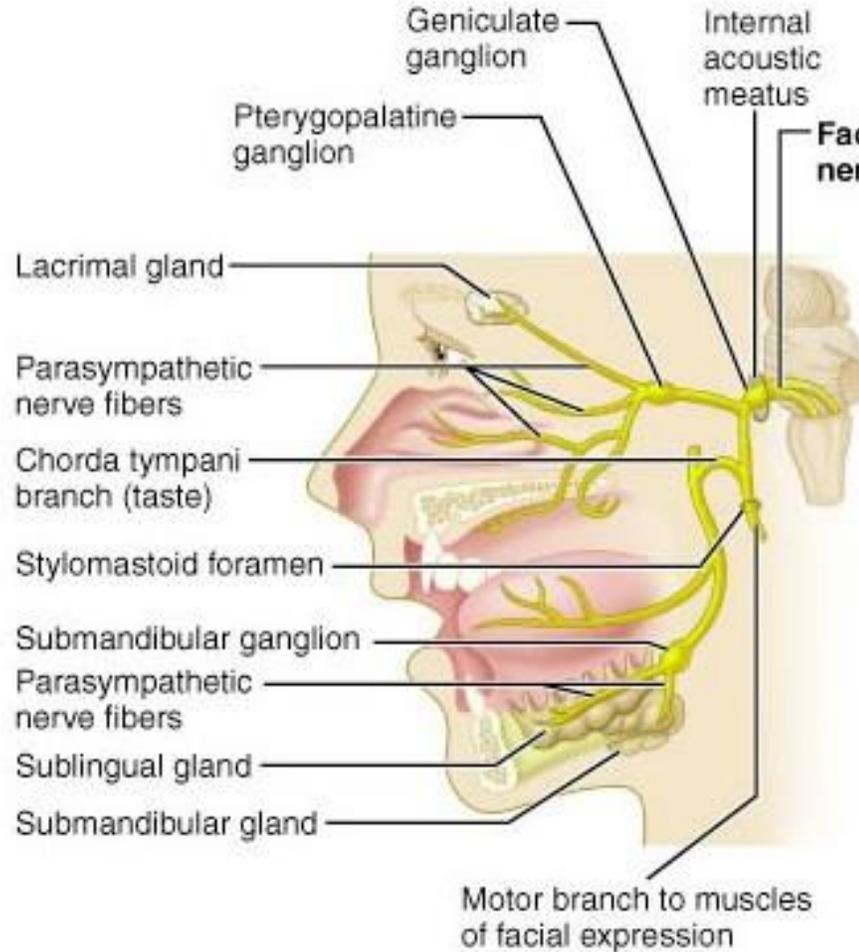
FACIAL NERVE NUCLEI

□ 4 nuclei: **SAQ**

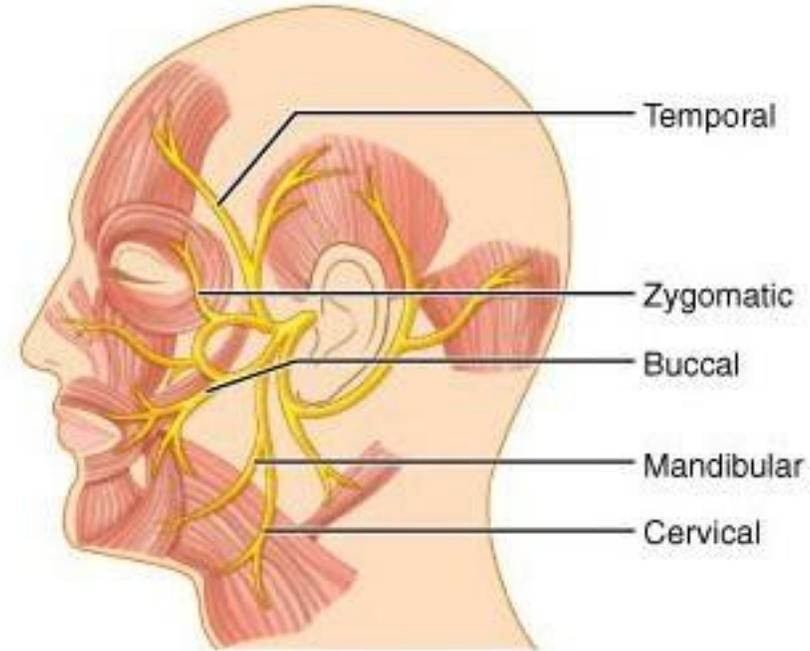
- 1) **Motor** nucleus:
 - lower Pons below 4th ventricle
- 1) **Superior salivatory** nucleus:
 - dorsal to motor nucleus
- 3) Nucleus **solitarius**:
 - medulla oblongata
- 4) **Spinal trigeminal** nucleus.



Cranial Nerve VII: Facial



(a) Parasympathetic efferents and sensory afferents



(b) Motor branches to muscles of facial expression and scalp muscles

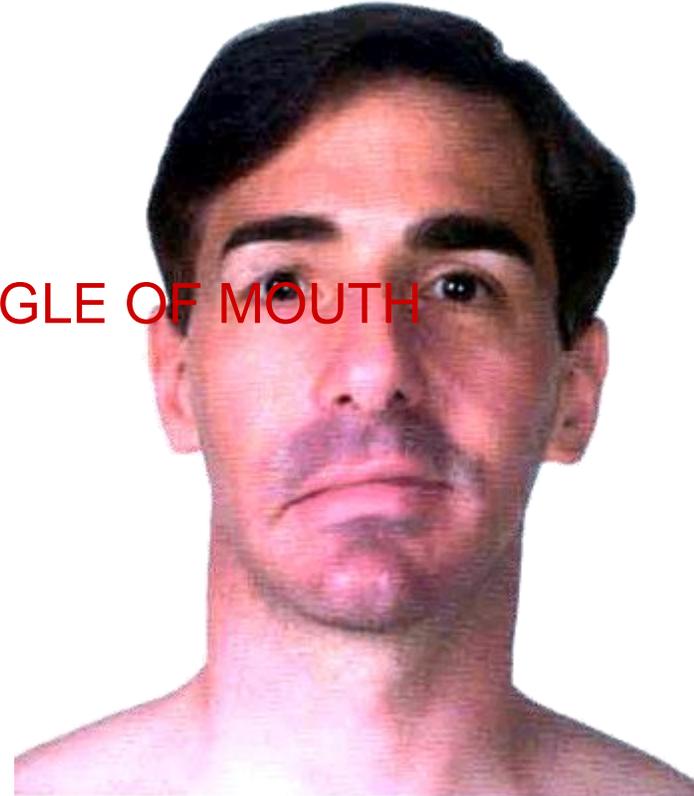
Facial nerve injury (Bell's Palsy)

SAQ



3 SIGNS OF LMNL

1. DRY EYE
2. DRY MOUTH
3. DROP OF THE ANGLE OF MOUTH

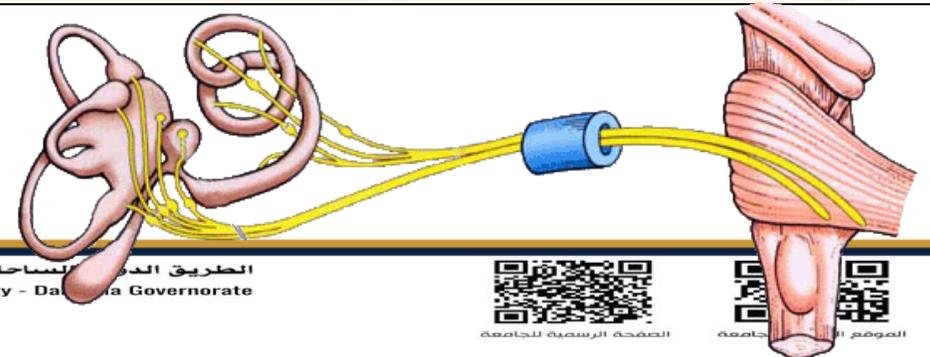
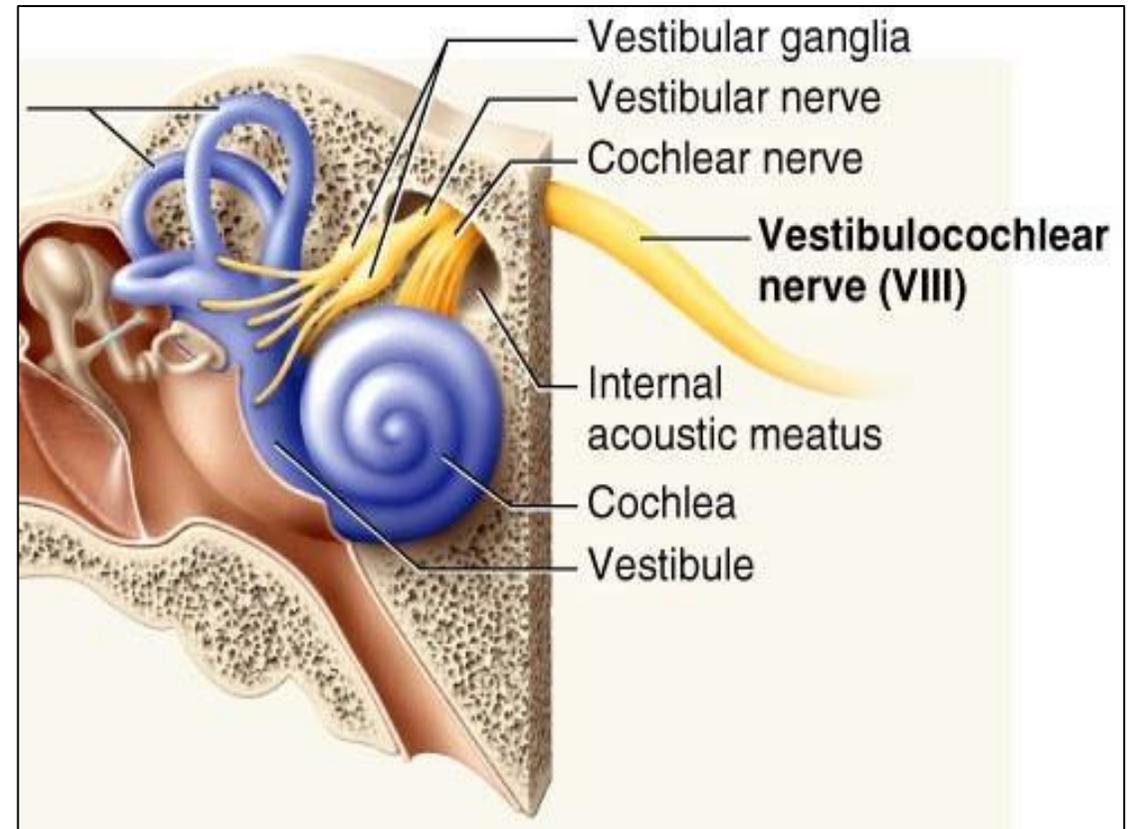


Cranial nerves – CN VIII

Vestibulo-Cochlear Nerve

Special sensory (SSA)

- **Vestibular part:** balance of body (position & movement of the head)
- **Cochlear part:** hearing
- Arise from the hearing and equilibrium apparatus of the inner ear, pass through the internal auditory meatus and enter the brainstem at the pons-medulla border
- LESION: **VERTIGO**



Quiz

1. Is the level of termination of spinal cord in **new born**
- a. 1st lumber
 - b. 3rd lumber**
 - c. 1st sacral vertebra
 - d. 3rd coccygeal

Quiz

Herniation of meninges, cerebrospinal fluid, spinal cord and/or spinal nerves is referred to as

- a. Spina bifida occulta
- b. Spina bifida with meningocele**
- c. Spina bifida with myelocele
- d. Spina bifida with meningocele
- e. Spinal dermal sinus

Quiz

Regarding denticulate ligaments

- a. Part of dura matter**
- b. Part of arachnoid mater**
- c. Lies only in cervical region of spinal cord**
- d. 21 processes in number**
- e. Is the only support of spinal cord**

Quiz

The cerebellum is developed from one of the following brain vesicles

- A. The Prosencephalon
- B. The Telencephalon
- C. The Diencephalon
- D. The metencephalon**
- E. The myelencephalon



Quiz

Which of the following sites the facial colliculus lie?

- A. Ventral aspect of pons
- B. Dorsal aspect of midbrain
- C. Ventral aspect of midbrain
- D. Dorsal aspect of pons**
- E. Ventral aspect of medulla oblongata

Quiz

Nucleus solitarius is responsible for which sensation

- A. Taste
- B. Equilibrium
- C. Proprioception
- D. Pain and temperature
- F. Touch

Answer: A



Quiz

Nucleus Ambiguous is a motor nucleus for which cranial nerve

- A. 3rd & 4th
- B. 5th & 6th
- C. 7th & 9th
- D. 9th, 10th & 11th
- F. 10th, 11th & 12th

Answer: D



Quiz

Which of the following best describes the internal carotid artery?

- A. One of two terminal branches of external carotid artery
- B. It supplies the occipital lobes and the brain stem
- C. It connects with the posterior cerebral artery through anterior communicating artery
- D. It connects with the posterior cerebral artery through posterior communicating artery
- E. It has a straight course along its length



Quiz

40% of the corticobulbar fibers from

- A. lower third of primary motor area 4**
- B. Upper two thirds of primary motor area 4**
- C. Habenular nucleus**
- D. General sensory area**

Quiz

40% of the corticospinal fibers from

- A. lower third of primary motor area 4
- B. Upper two thirds of primary motor area 4
- C. Habenular nucleus
- D. General sensory area

Quiz

Which of the following related to **hypoglossal nerve**?

- A. It is a mixed nerve.
- B. It exits from the post-olivary fissure.
- C. It supplies all muscles of the tongue except palatoglossus muscle.
- D. It arises from the upper five or six cervical segments of the spinal cord
- E. Its lesion results in paralysis of muscles of the larynx causes hoarseness of voice.

Quiz

Which of the following related to **glossopharyngeal nerve**?

- A. It supplies all muscles of the tongue except palatoglossus muscle.
- B. It exits from the pre-olivary fissure.
- C. Its lesion results in paralysis of muscles of the larynx causes hoarseness of voice.
- D. Its motor nucleus arises from middle part of nucleus ambiguous.
- E. Its parasympathetic nucleus(inferior salivatory nucleus supplies the parotid gland.**

Quiz

Paralysis of muscles of mastication on the same side of the head is caused by lesion of which cranial nerve?

- A. 3rd
- B. 5th
- C. 7th
- D. 9th
- E. 11th

Answer: B

Quiz

Ciliary ganglion is responsible for accommodation through which cranial nerve

- A. 3rd
- B. 5th
- C. 7th
- D. 9th
- E. 10th



Quiz

Which nerve supply muscles derived from the first pharyngeal arch?

A. Ophthalmic

B. Maxillary

C. Mandibular

D. Glossopharyngeal

E. Vagus

Quiz

Which nerve supply muscles derived from the 2nd pharyngeal arch?

A.Ophthalmic

B.Maxillary

C.Facial

D.Glossopharyngeal

E.Vagus

Quiz

Otic ganglion gives secretomotor fibers to parotid gland through which cranial nerve

A. 3rd

B. 5th

C. 7th

D. 9th

E. 10th



Quiz

Which of the following ganglia is related to lingual nerve?

- A. Ciliary
- B. Submandibular
- C. Pterygopalatine
- D. Otic
- E. Geniculate

Answer: B



Quiz

Which of the following related to the glossopharyngeal nerve?

- A. It carries the taste and general sensations from anterior 2/3 of the tongue
- B. It carries the taste and general sensations from posterior 1/3 of the tongue**
- C. Its motor nucleus arises from the middle part of nucleus ambiguus.
- D. Its parasympathetic nucleus arises from superior salivatory nucleus.
- E. It supplies the submandibular gland.

Quiz

Is the inducer (organizer) for neural tube development:

A. Notochord

B. Intermediate plate mesoderm

C. Lateral plate mesoderm

D. Ectoderm

E. Endoderm



Quiz

The caudal opening of the tube (**posterior neuropore**) closes on which day

A.18th

B.20th

C.22th

D.25th

E.27th



Quiz

A lesion in the following cranial nerve will cause vertigo and ataxia:

- a. Vagus nerve.
- b. Glossopharyngeal nerve.
- c. Hypoglossal nerve.
- d. Facial nerve.
- e. Vestibulocochlear nerve.**

Quiz

Is the level of termination of spinal cord during the 3rd month intrauterine:

A. 1st lumber

B. 3rd lumber

C. 1st sacral vertebra

D. 1st coccygeal

E. Entire length of the vertebral canal



Quiz

Spina bifida occulta occurs at which level

A.T11 or T12

B.L1 or L2

C.L3 or L4

D.L5 or S1

E.S1 or S2





Quiz

Inferior salivatory nucleus supplies the parotid gland through the

A. Glossopharyngeal

B. Facial

C. Accessory

D. Hypoglossal

E. Vagus



Quiz

Spinal nucleus of trigeminal mediates sensations from which cranial nerves?

A. 1st, 2nd and 3rd

B. 4th, 5th and 6th

C. 5th, 7th, 9th and 10th

D. 7th, 8th and 9th

E. 9th, 10, 11th & 12th



SAQ

Describe lumbar cistern:

Definition: sac of subarachnoid space filed with CSF

Extension: from L2 to S2 vertebrae

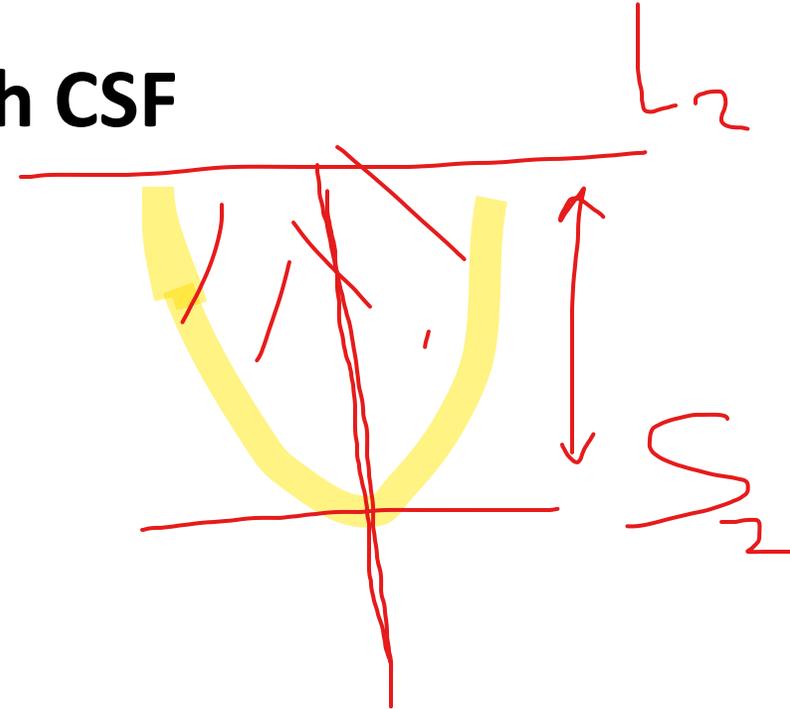
Contents:

1-CSF

2-Cauda equina

3-Filum terminale interna

Importance: for lumbar puncture



SAQ

Describe the arterial supply of the internal capsule

Anterior Limb: Dorsal 1/2: middle cerebral artery.

Ventral 1/2: anterior cerebral artery.

Genu: Anterior part: anterior cerebral artery.

Posterior part: post communicating artery.

Posterior Limb: Dorsal half: middle cerebral artery. **Ventral half: 1. Anterior 1/3:** posterior communicating artery.

2. Posterior 2/3: Anterior choroidal artery.

ICA: ACA & MCA

SAQ

Describe Age related changes In the position of the spinal cord

- 1) During the 3rd month intrauterine: extends through the **entire length** of the vertebral canal.
- 2) Later intrauterine: the spinal cord **ends at the level of the 1st sacral vertebra**.
- 3) At birth, this end is located at the **level of the third lumbar vertebra**. In the adult, the spinal cord terminates at the **level of the lower border of the first lumbar** vertebra. The nerve Fibers below the terminal end of the cord are known as the **cauda equina**

SAQ

Mention the three layers of the neural tube:

1. **Ependymal** layer: The original neuroepithelium (stem cells of nervous system).
2. **Mantle** cell Layer: neuroblast cells. (The Gray Matter).
- 3) **Marginal** layer: neuroblast fibers (The white matter).

Describe spina bifida

SAQ

Cause: non-fusion of the embryonic halves of the vertebral arches.

A. Spina bifida occulta:

Cause: failure of the embryonic halves of one vertebral arch to grow and fuse in the median plane.

Features: Occurs in **L5 or SI**, Occurs in **10%** of normal people.

B. Spina bifida with meningocele: herniation of meninges

C. Spina bifida with meningocele: herniation of meninges and spinal cord

SAQ

Summarize Arterial supply of the spinal cord

1-Anterior spinal artery:

origin: **one** artery from the **vertebral**

distribution: supply the **anterior 2/3** of spinal cord

2-Posterior spinal artery:

origin: **two** arteries from the **vertebral**

distribution: supply the **posterior 1/3** of spinal cord

3-Radicular arteries:

SAQ

Compare between superior and inferior colliculi regarding the points listed in the table

	Superior colliculus	Inferior colliculus
Connection to the opposite side	Connected by posterior commissure	Connected by commissure of inferior colliculus
Connection to the thalamus	Connected to lateral geniculate body by superior brachium	Connected to medial geniculate body by inferior brachium
Function	<ul style="list-style-type: none"> ➤ It is not relay nucleus in the visual pathway. ➤ An important visual reflex center. ➤ An auditory reflex center. 	<ul style="list-style-type: none"> ➤ A relay nucleus in the auditory pathway. ➤ An auditory reflex center for reflexes associated with sound





SAQ

Mention the beginning and termination of each of the following arteries:

1. Internal carotid
2. Vertebral
3. Basilar



SAQ

Mention deep origin of each of the following cranial nerves:

1. Oculomotor
2. Facial
3. Trigeminal
4. Glossopharyngeal
5. Vagus



